SCIENCE

FRIDAY, JANUARY 28, 1916

CONTENTS

The American Association for the Advancement of Science:—
The Isthmus of Panama in its Relation to the Animal Life of North and South America: PROFESSOR W. B. SCOTT 113

The Needs of Applied Optics: DR. P. G. NUTTING 124

Scientific Notes and News 128

University and Educational News 133

Discussion and Correspondence:—
Insects in their Relation to the Chestnut-bark Disease: F. C. CRAIGHEAD. *Cancer and Heredity:* MAUD SLYE. *A Mollusk Injurious to Garden Vegetables:* FRANK COLLINS BAKER 133

Scientific Books:—
La Science Française: PROFESSOR WM. H. HOBBS 136

Scientific Journals and Articles 138

Special Articles:—
The Poisonous Effects of the Rose Chafer upon Chickens: GEORGE H. LAMSON, JR. ... 138

The American Society of Zoologists: PROFESSOR CASWELL GRAVE 139

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ISTHMUS OF PANAMA IN ITS RELATION TO THE ANIMAL LIFE OF NORTH AND SOUTH AMERICA[1]

IT is a commonplace of geological teaching that the past can be understood only through a knowledge of the present and it is equally true that the present can be fully comprehended only through a knowledge of the past. Each must be employed to elucidate the other and we must pass from one to the other, as new discoveries are made in either realm.

The problems which deal with the existing geographical distribution of animals have received much light from the progress of paleontological discovery and the present arrangement is clearly seen to be the necessary outcome of an illimitable series of past changes, climatic, geographical and biological. Even in pre-Darwinian days the geographical distribution of animals had been given much attention, as a collection of interesting facts, though, under the belief in special creation then prevailing, no explanation of those facts was possible. The general adoption of Darwin's views immediately placed the subject in a new light, for it was at once seen that, unless the theory of evolution could offer a rational and satisfactory solution of these problems of distribution, the foundations of the theory would be greatly weakened.

No result of paleontological studies has, of late years, been more striking than the clear recognition of the fact that migra-

[1] Lecture before the American Association for the Advancement of Science at its San Francisco meeting, August, 1915.

tions from continent to continent have played a highly significant part in bringing about the present geographical arrangement of animals and plants. This conception was first suggested by Cuvier, who, however, would seem not to have attached great importance to it, and it fell into neglect together with his theory of Catastrophism. Present geographical distribution is, when well understood, in itself a partial record of those past changes, partial, because of the extinction of many forms which, in every region, once existed, but have completely vanished. Such migrations from continent to continent were, it should be distinctly understood, radically different in character from the annual migrations of birds, and it is unfortunate that the same term should be used to designate such very distinct classes of facts. The so-called migrations with which we have to deal, such as those of mammals, are a purely unconscious and unintentional spread into new areas, as the increasing number of individuals of a given species begin to press upon the sources of food-supply. This spread will continue from generation to generation until insuperable barriers are encountered and there the spread must cease, unless some geographical or climatic change should remove the barrier, when the spread will continue. For nearly all land animals the most impassable of barriers is the sea, even in narrow arms, though the climatic factors of temperature and, in somewhat less degree, moisture are of almost equal importance. In the long course of geological time and even in its later portion, with which we are here more particularly concerned, both the relations of the various continents to one another and climatic conditions have undergone great and repeated changes, and it is those changes, with their consequently varying possibilities of intermigration, which are registered in the geographically composite fauna of almost every great land area of the earth. Enough has been already learned regarding the history and development of the various mammalian groups to make it plain that the mammals of each different continent form a sort of mosaic, the parts of which are of the most diverse places of origin and dates of immigration. The geological date largely determines the amount and kind of modification which the creatures have undergone in their new homes.

In attempting to estimate the significance of these facts, one assumption must be made, an assumption for which there is a large and increasing body of evidence, namely, that, in the higher animals at least, the same group never originated independently, from ancestors either similar or different, in two disconnected regions. It is perfectly true that parallel and convergent modes of development have always been important factors in the evolutionary process, and no one is more firmly persuaded of this than the paleontologist, but there is no reason to believe that these modes of development ever went so far as to produce substantially identical results in separate land areas. These principles are best illustrated by the mammals, simply because the past geological history of that group has been ascertained more fully and continuously than that of any other class of animals.

The scheme for dividing the land surface of the globe into zoological regions, in accordance with the distribution of animals and especially of mammals, has been the subject of much controversy, but now a general agreement has been reached. Thus, the very long isolation of Australia is recognized by setting off that continent and its adjoining islands, in contradistinc-

tion to all the rest of the world; it is the empire of marsupials and monotremes, while the other continents together constitute the empire of the placental mammals. This placental empire is, in turn, very unequally divided into two realms; the first, called *Arctogæa,* comprises North America, Europe, Asia and Africa and has an unmistakable general similarity in its mammals, in contrast to the second realm, *Notogæa,* which includes South and Central America and the West Indies. After Australia, Notogæa is zoologically the most peculiar region of the earth, a peculiarity which is likewise due to its long separation from the continents of Arctogæa.

The frequently made and interrupted communication of North America with the eastern hemisphere, principally by way of a land which occupied the site of the present shallow Bering Sea, is reflected in the geographically composite character of its mammalian fauna. This connection allowed intermigrations of animals between the eastern and the western hemispheres, each furnishing to the other elements which still persist in their new homes, though often becoming extinct in their places of origin. For example, the horses and camels have disappeared from North America, although they passed through the greater part of their development in that continent. The last of these migrations, which took place in the Pleistocene epoch, brought in such a host of Old World types, that the northern half of North America, comprising the Arctic and Boreal Zones of Merriam, belongs zoologically to the great Holarctic Region, which includes Europe, northern Africa and all of Asia except its southern peninsulas and thus encircles the earth.

The characteristic part of North America is the Sonoran Region, roughly the United States and the Mexican plateau, and ever this region contains many Old World forms, immigrants which arrived here at very different geological dates and, in accordance with the length of their stay here, have become more or less extensively modified. With these are associated many indigenous types, derived from a long North American ancestry and a very few migrants from South America, the short-tailed porcupine, probably the opossums, and in southeastern Texas an armadillo. These southern animals are the insignificant remnant of a great immigration which entered North America from the south, but was not able to gain a lasting foothold here.

South American mammals are obviously divisible into two radically different assemblages, one of which is related to the types characteristic of Arctogæa and the other is entirely peculiar to Notogæa. The first, or immigrant, assemblage comprises all the beasts of prey, the wolves, cats, otters, skunks and one species of bear; all of the hoofed animals, the tapirs, peccaries, deer, and that remarkable section of the camel family, the guanacos, llamas, etc.; among the rodents, the rabbits, squirrels, rats and mice. The second, or indigenous, series includes the opossums, the highly characteristic edentates, sloths, armadillos and anteaters, and a very large number of peculiar rodents, all of which belong to the porcupine group, tree-porcupines, chinchillas, cavies, water-hogs, etc., etc. The paleontological history of South American mammals amply justifies the distinction of these two assemblages as immigrant and autochthonous and shows that South America derived from the north a much larger proportion of its modern mammals than North America did from the south.

It is altogether probable that in the Mesozoic Era all of the continents were

directly or indirectly connected with one another, though it is not necessary to suppose that these connections all existed at the same time. In the Cretaceous Period every continent, even Australia, had its Dinosaurs, huge, slow-moving, land reptiles, which could not have crossed wide arms of the sea, but were dependent for their spread upon continuity of land. It may likewise be assumed that the minute and primitive mammals of the Mesozoic had a similar, world-wide distribution, though the data are still too scanty to permit any positive statements with regard to them. Early in the Tertiary Period of the Cenozoic Era, South America was completely cut off from any land communication with North America, assuming that such communication had previously existed, as it probably had. Thenceforward and for a very long period of time, the faunas of the two American continents developed in entire independence of each other and with remarkably different results.

To the student who is familiar with the Oligocene and Miocene mammals of the northern hemisphere, it is like entering a new world, when he begins to examine the mammalian faunas of the Deseado and Santa Cruz formations of Patagonia. In any comparison between the homotaxial faunas of North America and Europe, the differences are in species and genera, less commonly of families, but between South America and the northern hemisphere it is mainly a difference of orders. These Patagonian faunas contain no Carnivora, Artiodactyla, Perissodactyla or Proboscidea, the groups which were most abundant in Arctogæa. Beasts of prey were numerous and varied, but they were all predaceous marsupials; two other groups of marsupials, the opossums and cœnolestids, were also common, at a time when the whole order had vanished from the northern hemisphere, apparently even from North America. An extremely abundant, diversified and conspicuous element of the fauna, especially in the Santa Cruz and subsequent formations, was the characteristic South American order of the Edentata, which included the ground sloths, armadillos and glyptodonts, none of which appeared in the northern hemisphere till a long subsequent period, with the doubtful exception of the armadillos. True sloths and anteaters have also been reported by Ameghino from the Santa Cruz, and although the evidence for this determination is insufficient, it is altogether probable that these groups were already in existence in the forested regions of the north, if not on the plains of Patagonia, which would seem to have had but few trees at that time. At all events, arboreal animals are rare or absent from the fauna.

The very large assemblage of hoofed animals all belonged to groups which are now altogether extinct and no member of which has ever been found outside of South and Central America, the toxodonts, typotheres, homalodotheres, astrapotheres and litopterns, a wonderful series, which took the place of the hoofed mammals of Arctogæa and would appear to have been strictly autochthonous. Aside from the Insectivora, which, as being of great geological antiquity and nearly cosmopolitan in their distribution, have little bearing on the problems with which we are now concerned, only two mammalian orders occurred in the Santa Cruz fauna which at the same time existed in the northern hemisphere, the rodents and the monkeys. The remarkably diversified and numerous rodents all belonged to the Hystricomorpha, or porcupine-group, of which North America never had a representative until the coming in of the great immigration from the south and to-day has only the short-tailed porcupine. South

America then had no hares, rabbits, pikas, squirrels, marmots, beavers, rats or mice, but in place of them had a host of cavies, chinchillas, agoutis, and several other families, all of which still abound in the southern continent. The South American monkeys present a problem of much difficulty; all our present knowledge justifies us in saying that they could not have come from North America, for that continent never had any monkeys and even the lemurs became extinct here after the Eocene.

The Miocene faunas of North America are in the sharpest possible contrast to those of South America. They contained several families of true Carnivora, wolves of many diverse kinds, saber-toothed tigers and true cats, weasels, martens, otters, raccoons, and the like; a great abundance and variety of hoofed animals belonging to the artiodactyls and perissodactyls, horses, tapirs, rhinoceroses, chalicotheres, peccaries, camels, llamas, deer, antelopes and certain families, such as the highly characteristic oreodonts, which are now extinct, while the earliest of American mastodons had already made their way in from the Old World. The rodents, though including some very bizarre forms, now extinct, all belonged to the familiar northern families, rabbits, squirrels, marmots, beavers, pocket-gophers, jumping mice, kangaroo rats, vesper mice, etc., etc. There were no marsupials, edentates (with an exception to be noted subsequently), monkeys, rodents of the southern families, nor any of the remarkable hoofed animals which then swarmed in such multitudes in South America. Nothing could be more obvious or more assured than the conclusion that the two Americas had long been so completely separated that no migration of land animals from one to the other was possible and, in this long interval, the operation of divergent evolution had brought about this total disparity and unlikeness of faunas.

The junction of the two Americas, by way of the Isthmus of Panama, would seem to have been effected early in the Miocene epoch, or possibly even at the close of the Oligocene, and then began the slow process of the intermigration of land animals in both directions. The earliest indication of the animal of Notogæan forms in North America is the claw of a ground-sloth, discovered by Sinclair in the middle Miocene of Oregon but it was not till the Pliocene and, more strikingly, in the Pleistocene, that the southern immigrants arrived in large numbers, and in South America no northern types have been found in beds older than the Paraná formation, which I believe to be Pliocene, but which may prove to belong to the later Miocene.

As thus recorded, the process of mammalian diffusion might seem to be incredibly slow, but there are several considerations which help to explain the extreme tardiness with which the exchange of animals between the two continents was carried on. (1) The Miocene mammalian faunas which have as yet been recovered are in the far north and the far south and we know nothing of the intermediate regions, Central America, northern and middle South America. (2) As previously pointed out, the so-called migration of mammals is merely a gradual spread, a wider and wider range, as increasing numbers demand fresh sources of food. (3) For a considerable period after the upheaval of a sea-bottom into land, it must remain impassable to most mammals, because devoid of vegetation, and until plants have taken possession of it, it can serve as only an imperfect and difficult means of communication. (4) Another and very important obstacle to migration between the Americas was that it took place along the lines of longitude

and thus encountered differences of climate, which are among the most effective barriers to the spread of mammals, while between North America and the Old World the migrations followed the lines of latitude and therefore, to all appearances, were accomplished much more quickly. (5) Finally, it is not to be supposed that the fossils already discovered make up anything like a complete list. Doubtless, many things still remain to be found, and others, because of rarity or some other unfavorable circumstance, failed altogether of preservation, and the actual progress of diffusion may well have been more rapid and effective than the observed facts would lead us to suppose.

In the middle and later Pliocene and still more in the Pleistocene the intermigration had proceeded so far that the two continents possessed a very considerable number of mammalian genera in common, as immediately appears from a comparison of the faunal lists. The movement culminated in the Pleistocene, where the number of southern forms in the northern continent and of northern forms in the southern lands reached its maximum. In both continents the Pleistocene mammalian fauna was a very much richer and more varied assemblage than the modern one, for the great and mysterious extinctions which came late in the epoch and at its close, devastating more than three fifths of the land surface of the earth, were especially severe in North America and left that continent in a zoologically impoverished state. Beside almost all of the existing mammals which still continue to inhabit the region, Pleistocene North America had mastodons, three species of elephants, several tapirs and ten species of horses, ranging in size from small ponies to species which exceeded the largest modern draught horses. Peccaries spread as far north as Pennsylvania and from ocean to ocean and were accompanied by great herds of camels and llamas. Seven species of bison, some of them far surpassing the existing buffalo, so-called, were distributed from Florida to Alaska, while musk-oxen and allied forms extended far to the south and along the Pacific coast into California. Modern types of deer and antelopes were associated with several extinct types, some of which must have been very grotesque in appearance. Especially remarkable is the discovery by Gidley in western Maryland of an antelope which is hardly distinguishable from the recent African Eland. Almost all the existing North American beasts of prey have been found in the Pleistocene, but there were many more that are now extinct and were of extraordinary size and power; giant wolves, lions, the terrible saber-toothed tigers and the huge short-faced bears are examples of these vanished forms, the disappearance of which made life much easier for early American Man.

All of the animals so far enumerated are typically Arctogæan in character and were either immigrants from the Old World, of various geological dates of arrival, or were of indigenous North American ancestry and development, but mingled with those were many South American mammals, the history and evolution of which can be followed in satisfactory detail in the successive Tertiary formations of that continent. The strangest and most conspicuous of those migrants from the south were the great edentates. The huge, elephantine ground-sloths, a group now entirely extinct, but very abundant in the Pleistocene of both North and South America, ranged all across the continent from Pennsylvania to California. The genus *Megalonyx,* which, it is interesting to note, was first named by Thomas Jefferson from some bones found in Virginia, would seem to

have been a forest-living creature, and, so far as is now known, was confined to the region east of the Mississippi River. The almost equally massive *Mylodon* replaced it over the Great Plains and on the Pacific coast, particularly fine specimens occurring in the wonderful asphalts of Rancho la Brea, which the work of Professor J. C. Merriam has rendered so celebrated. A third genus, *Megatherium*, of even greater size and heavier proportions, extended into Georgia and South Carolina, but is not known farther north, as it was probably unable to endure a cold climate. Those most grotesque beasts, the Glyptodonts, which were like enormous armadillos in appearance, accompanied the ground-sloths in their migration to North America, but have been found only in the southern states, from Florida to Texas and Mexico, being doubtless limited in their northward range by the barrier of climate.

The Pleistocene rodents tell a similar story. Practically all of the modern forms were already here and associated with these were certain strange and curious forms, like the giant beaver, of northern origin, but now extinct, and a few South American immigrants, like the short-tailed porcupines and the water-hogs, of which only the former have survived. The marsupial group of the opossums had in the Eocene epoch extended over Europe and the Americas, but none have been found in North America in beds later than the Oligocene. Of course such small animals may have merely escaped the collector's eye, but, taking all things into consideration, it is probable that the group vanished completely from the northern hemisphere and returned with the immigration from South America, where they had continued to flourish without interruption.

The Pleistocene fauna of South America was likewise much richer and more varied, especially in very large mammals, than is the existing one, and is far stranger than the corresponding one of North America, differing more radically from that of modern times, for the extinctions swept away not only species and genera, but whole families and orders as well. The pampas of Argentina, the caverns of Brazil and, in lesser degree, areas in Bolivia and Ecuador, have yielded a marvelous series of Pleistocene mammals, which give a very striking picture of the life of the times. The same distinction between immigrant and autochthonous types which was noted in the existing fauna of South America was as strongly marked in the Pleistocene. Beside those northern immigrants which have maintained their foothold in the southern continent and are represented there to-day, there are many others which are now extinct, some of those groups which have become altogether extinct, others which have vanished from the western hemisphere, or from South America only. The Pleistocene fauna had substantially all of the mammals which still inhabit Notogæa and it is therefore unnecessary to repeat the names of those which form part of the modern fauna. It may be noted, however, that some of the recent families had representatives much larger in size than any that now exist, such as the monkeys and the raccoons, above all, the armadillos.

Some of these extinct immigrants were very abundant and conspicuous in the Pleistocene. The great saber-toothed tigers ranged all the way from Pennsylvania and California to the Argentinian pampas and were accompanied by the short-faced bears. A strange feature was the presence of a wolf which is apparently referable to the same genus (*Cyon*) as the wild dog or Dhole, of recent India. Horses were very common wherever Pleistocene fossils have

been found and must have arrived in South America at a relatively early date, for several highly peculiar and aberrant types were developed. One of these (*Hyperhippidium*) found in the Andes, was a small, mountain horse, with remarkably short feet which were well adapted to climbing. Tapirs ranged down into Argentina, much farther south than at present, but were not otherwise noteworthy. The range of the llamas also was much greater than it is to-day; now, they are restricted to the colder parts of the continent, but in the Pleistocene they extended into the forests of Brazil. Two antelopes have been reported, a family of which Notogæa has now no representatives. Mastodons of several species have been found in many parts of the continent, but, curiously enough, the true elephants did not accompany them in their southward migration. Why this was, it is difficult to say; perhaps because the North American elephants, which came in by way of Siberia, were cold-country species and therefore unable to cross the tropics.

The Pleistocene extinctions worked even greater havoc among the autochthonous forms than among the immigrants, destroying almost all of the very large mammals whose history and development may be traced back, step by step, through the successive divisions of the South American Tertiary. The visitor to the museums of La Plata and Buenos Aires can not but be deeply impressed by the number and variety of the ground-sloths and glyptodonts from the Pampean formation which are there displayed; it is immediately evident that the members of those groups which inhabited Pleistocene North America were but the outlying stragglers of the far more numerous and incomparably more diversified assemblage found in South America. They were indeed a strange and grotesque host of ponderous, slow-moving, but inoffensive plant-feeders, which, together with the almost equally bizarre indigenous hoofed animals, gave a most outlandish character to the fauna. The ground-sloths ranged in size from a tapir to a short-legged elephant; *Megatherium* even surpassing the elephants in massiveness of trunk and limbs. The glyptodonts differed much among themselves in size, in the character of the head, in the form of the solid and heavy carapace, but especially in the armature of the tail, which, in some cases at least, must have been a formidable weapon of defence. It is usual to call the glyptodonts "giant armadillos," but that term is more properly applied to certain huge animals, as large as a rhinoceros, which were true armadillos. The largest existing species of the group is hardly more than a yard long.

Among the hoofed animals, three of the native groups, the toxodonts, typotheres and litopterns, which were so remarkably abundant and varied in the Santa Cruz Miocene, persisted into the Pleistocene and then became extinct. Evidently they had begun to decline long before that epoch, possibly because of the competition of the more advanced and highly organized intruders from the north, though certain series continued to progress in size and differentiation of structure until the end of their career. One of the most characteristic of these animals was *Toxodon,* of which two skeletons are mounted in the La Plata Museum. The genus was found by Charles Darwin, who says of it: "Perhaps one of the strangest animals ever discovered; in size it equalled an elephant or megatherium, but the structure of its teeth, as Mr. Owen states, proves indisputably that it was intimately related to the Gnawers [*i. e., Rodentia*] . . . in many details it is allied to the Pachydermata: judging from

the position of its eyes, ears and nostrils, it was probably aquatic, like the Dugong and Manatee, to which it is also allied." Darwin's scanty materials led him to exaggerate the size of this extraordinary beast and his views as to its diverse relationships are not tenable from the modern point of view, but his brief description brings out the strangeness of structure in a vivid way. *Toxodon* ranged as far north as Nicaragua, but, so far as is known, did not enter North America proper.

Somewhat distantly related to *Toxodon* was the equally strange *Typotherium,* an animal of moderate size, which was the last of a very long series of native developments. Its permanently growing, chisel-like incisors are so similar to those of the rodents that the genus was long referred to that order. Typotheres were extremely numerous in the Santa Cruz times, but declined rapidly in relative importance after that and disappeared completely at the end of the Pleistocene.

Of all the many bizarre animals which swarmed in Pleistocene South America, none was more extraordinary than *Macrauchenia,* which, like *Toxodon,* was one of Darwin's discoveries, when he was on the memorable voyage of the *Beagle. Macrauchenia* was somewhat like a large camel in proportions, but of much heavier build. The head was relatively small and must have had quite a long proboscis, which added much to the grotesque appearance of the creature. The neck was very long, suggesting that the animal browsed upon trees, which is also indicated by the character of the teeth; the legs were long and heavy, the feet short and each provided with three toes. This was the last of the Litopterna, an exclusively South American group which had for a long period played a very conspicuous rôle in that continent, but, like the typotheres, had begun to decline in numbers after the Santa Cruz epoch.

The rodents of the South American Pleistocene do not offer much that is of particular interest. The presence of North American types of meadow-mice, which no longer exist in the southern continent, is a noteworthy fact, as is also the occurrence of *Megamys,* an extinct representative of one of the indigenous families. This was the largest of all known rodents, living or fossil, and rivalled the rhinoceros in size—for a rodent, a veritable monster.

From this comparison of the North and South American faunas, as they are revealed in the geological succession, certain facts stand out saliently. (1) It is evident that North America contributed much more extensively to the southern fauna than South America did to the northern. Even in the Pleistocene, when the movement of intermigration had reached its maximum and there were more mammalian types common to the two continents than at any other period, before or after, the number of Notogæan types found in North America was really very small; opossums, a few rodents, ground-sloths and glyptodonts complete the list. Of these only the opossums and the short-tailed porcupines have survived to modern times. On the other hand, the list of northern forms which, before or during the Pleistocene epoch, had invaded the southern continent, is very much longer; bears, cats, saber-toothed tigers, weasels, otters, skunks, raccoons, dogs of many kinds, rabbits, squirrels, rats, mice, horses, tapirs, peccaries, deer, antelopes, llamas and mastodons, all found their way into South America and most of them still inhabit that region. The short-faced bears, saber-toothed tigers and the mastodons became extinct everywhere; the horses died out completely in the western hemisphere, while the ante-

lopes and meadow-mice vanished from South America, though persisting in North America. The permanent contribution of South America to the northern fauna is, on the contrary, quite insignificant.

While it is impossible to say with any certainty just why the northern animals should have thus predominated over the southern, it is reasonable to conclude that it was due to the higher stage of intelligence and structural development which the former had attained. There can be no question as to this structural superiority, but such superiority, as we call it, does not always insure victory in the struggle for existence, victory largely depending upon the nature of the environment. It must be remembered that by no means all of the northern animals which invaded Notogæa were of North American origin; many were immigrants from the Old World, of different geological dates of arrival in the western hemisphere and correspondingly different degrees of modification. The repeated junction of North America with Asia made the former a part of Arctogæa, incomparably the greatest land area of the globe, and such immensity of connected lands is favorable to the higher evolution of terrestrial life. The comparative isolation of South America kept that continent in a relatively backward state.

(2) The very different degrees of likeness and unlikeness between the faunas of the two continents in the successive geological epochs point unmistakably to extensive geographical changes. Beginning with a time of radical difference, when the two faunas had almost nothing in common, the story goes on to tell of a period when an exchange of mammals began, gradually extending until a very considerable number of types common to both continents was found, and finally reducing the number of these common types to the present condition. The obvious interpretation of these facts is that the complete dissimilarity of animals was due to an equally complete separation of the continents and that a certain degree of likeness was brought about when a land connection was established. Well-founded as this conclusion appears to be, confirmation from a quite independent line of evidence would be welcome and such evidence is to be obtained from the geology of Central America and the Isthmus of Panama.

(3) Intermigrations between the Americas have always had to contend with serious obstacles and difficulties; otherwise, the interchanges of land animals would have been much more extensive than they ever became. Then, too, it would seem that there have been times in the past when migration was less difficult than it is at present, for now there is little or no indication of such movements. As was previously shown, the principal barrier to the spread of mammals over connected or continuous lands is climate, and it follows that the times of migration were those of more favorable climatic conditions. In the early Miocene, when the migrations probably began, the climate was much milder than at present, with less difference between the tropical and temperate regions. Through nearly the whole of the Tertiary period these conditions persisted, though with a slowly progressive refrigeration, and even in the Interglacial of the Pleistocene, the amelioration of climate was such that migration was rendered more practicable than it is under existing circumstances.

The geological structure and history of the lands around the Caribbean Sea are not nearly so well known as would be desirable, but certain very significant facts have already been ascertained. Especially is this true of the Isthmian Canal Zone,

which has been studied by Macdonald. There is very little direct information, as yet, regarding the condition of Central America and the Isthmus of Panama during the Eocene, whatever rocks there may be in the region of Eocene or earlier date being buried under newer formations. It is clear, however, that in the succeeding Oligocene epoch the whole Caribbean region was extensively submerged; the Greater Antilles were much reduced in size and nearly the whole of Central America was under water, a broad sea separating North and South America, though doubtless with scattered islands. On the Caribbean side of the Isthmus is a very thick mass (estimated at 2,500 feet) of Oligocene strata, the Gatun formation, which is crowded with marine fossils. The Culebra Hills, through which the great cut has been made, are chiefly built up of volcanic materials, lava streams, mud-flows, tuffs, etc., in a very complicated arrangement, and running through the cut may be traced thin bands of a marine limestone, which carry Oligocene fossils. The evidence of submergence is thus complete, but the date of upheaval can not be very definitely fixed. Except for a narrow strip of Pleistocene on the Caribbean coast, no marine rocks later than the Oligocene have been found on the Isthmus and it would be natural to conclude that the elevation came at the close of that epoch. Some allowance must, however, be made for erosion and it is quite possible that early Miocene rocks were formed and have since been swept away. The ground-sloth in the middle Miocene of Oregon is proof that the connection was established at least as early as that.

In the Pliocene and perhaps early Pleistocene the isthmian region was considerably broader than it is now and it is probable that the flat lands lying along the then existing coast afforded a comparatively easy highway of migration, the chief obstacles to which were climatic rather than topographical, but during some part of the Pleistocene the Isthmus was again depressed and narrowed even beyond its present limits, as is shown by the fringe of marine deposits along the Caribbean coast.

Central America, like the West Indies, belongs zoologically to South America and forms a part of the Neotropical Region. This fact is not altogether easy of explanation. It may be that the Isthmus connected South and Central America at a time when the latter was still separated from the northern continent. Were this the case, the southern fauna would have had the advantage of possession, when the northern invasion began. On the other hand, the cause may be entirely climatic and that this is the rightful conclusion is indicated by the distribution of animals now obtaining in Mexico. The high table-land of that country contains an extension of the North American fauna, while the tropical lowlands are South American.

It is a truism to say that the Isthmus of Panama is the strategic key to the zoological relations of North and South America, and yet it was not necessarily so, as other lines of communication might conceivably have been established. So far as our knowledge extends, however, the geographical events in the history of the Isthmus dominated the biological interrelations of the continents which it now unites. When the Isthmus was submerged, South America was in a state of nearly or quite complete isolation and developed a highly peculiar fauna, few elements of which were shared with any other continent, and which was as unique in its way, though on a higher plane, as is the Australian. It was, so to speak, a highly interesting experiment in evolution; a great continent,

with varied climate and a great diversity of conditions, mountains and valleys, forests and open plains, left through long ages entirely to its own resources, was the closed arena of rapid development divergent from the rest of the world. The result is plainly obvious now. Though the elevation of Central America and the Isthmus into land joined Notogæa with the northern continent and the way of migration thus opened led to an extensive infusion of northern elements in the southern fauna, South America still remains, after Australia, the most peculiar region of the earth.

North America had quite a different fate; its connection with the south was a mere episode which led to the transitory reception of a considerable number of Notogæan forms and the permanent establishment of a very few. Its oft-repeated connection with the Old World was far more significant from the zoological point of view, for that maintained the essential community of mammalian life all over the northern hemisphere. To this connection it is due that North America is a part of Arctogæa and that its Arctic and Boreal zones are inseparable from the great Holarctic Region of Europe and Asia. In the Pliocene and Pleistocene, North America was the meeting-ground of currents of migrating animals, from the west and from the south and for a time the fauna was of an exceptionally composite character, Old World and Notogæan elements mingling with the richly variegated indigenous stocks. But this condition was much modified by the Pleistocene extinctions which almost entirely exterminated the invaders from the south and greatly reduced the number of autochthonous forms. The destruction of immigrants from the Old World was less extensive and thus the zoological relations of North America in the Pliocene and Pleistocene were quite different from what they are now.

The problems which deal with the possible connections of South America with continents other than North America and especially with Africa and Australia, are extraordinarily interesting from many different points of view, but there is no time to enter upon a discussion of them here, nor are they altogether germane to the subject before us, which is the zoological relations of the western hemisphere as conditioned by the Isthmus of Panama and its geographical history.

W. B. Scott

Princeton University

THE NEEDS OF APPLIED OPTICS[1]

We have formed this Association for the Advancement of Applied Optics because we believe that the interests of all branches of applied optics may be materially furthered by such an organization. It seems fitting, therefore, to devote this first meeting to a discussion of the needs of applied optics and to the outlining of plans for securing the advancement desired.

The interests of every one who uses light are affected by applied optics in its broader interpretation. In the formation of this society we have invited the cooperation of all who are directly interested in the study and use of light and of optical instruments of all kinds. We therefore include, among those whose interests we aim to serve, astronomers, designers of optical instruments, illuminating engineers, photographers, ophthalmologists, photometrists, colorists, petrologists, microscopists and all investigators of optical problems. The field to be covered is broad and the interests affected many and diverse.

[1] An address inaugurating the formation of the Association for the Advancement of Applied Optics delivered at the first meeting held in Rochester, January 4, 1916.

Beyond question, the greatest present need of applied optics is cooperation. Workers in one field are often lacking in knowledge of the data, methods and principles developed by those in other fields. For example, the illuminating engineer desires more complete information relating to photometry, radiation laws, scattered light, and above all on the properties of the retina upon which depend the conditions for best illumination. Such information is difficult to obtain in any case and much of it is not available at all. Again, either the eye or a photographic plate is an essential part of every optical instrument, yet what designer of optical instruments posesses a full knowledge of the characteristic properties of either? The ophthalmologist desiring to know more of the nature and properties of light is confronted by a highly technical mass of information, largely in mathematical language and almost useless to him. A great many persons, vitally interested in the color of materials, are almost entirely without information as to the precise analysis or synthesis of color. Nearly every one could make good use of a knowledge of the conditions of illumination conducive to the best seeing, yet evidences of profound ignorance of those conditions are on every hand. Similar instances of lack of coordination of interests in applied optics might be multiplied indefinitely.

We believe that such a condition of affairs is best met by the formation of such a society as this. It is our aim to provide for the free interchange of ideas in the meetings of this society. A clearing house and a storehouse of data and information will best be provided by the establishment of a journal for the publication and dissemination of new and useful material in the various fields of applied optics. As soon as such material shall have reached a permanent form, it should be crystallized in convenient books of reference. The need for the organization, the journal, and for reference texts will hardly be questioned by any one.

Aside from the need for cooperation and the dissemination of the knowledge already available in the various fields of applied optics, the great need is for more information along various lines. It is a fitting occasion to briefly review the several branches of applied optics, calling attention to fields of research in which investigation appears to be most urgently needed.

The very ground work of all applied optics is of course pure optics. Little progress can be made without a thorough knowledge of the laws of the refraction, reflection, absorption and emission of light, nor of diffraction, interference, scatter or polarization. Most of these laws are well known and familiar but there are conspicuous exceptions of vital importance in applied optics. The laws of radiation applicable to a perfect radiator are fairly complete but very little is known of the corresponding laws applicable to the practical case of heated bodies or to gases conducting an electric current. While the laws of reflection and refraction are commonly considered well known, as a matter of fact we know almost nothing of the laws applicable to a layer whose thickness is comparable with the length of a light wave. In this case practise has not waited for theory, for lens surfaces are said to have been prepared giving greatly decreased loss of light by reflection. Another and conspicuous gap in our knowledge of pure optics relates to heterogeneous media. Light is scattered by small particles and absorbed by still smaller ones but very little attention has been given to the laws governing the scatter and diffusion of light so important in illuminating engineering.

In the field of lens calculation, though

great results have been achieved, our methods and mathematical tools are those of fifty years ago. We still calculate lenses largely by the cut and try method of triangulating a bundle of rays through the lens and finding whether they meet in the image plane. It is possible that no other method of calculating lenses will ever prove of practical value, yet a number of our ablest mathematical physicists have attempted to apply the best modern mathematical methods to lens design. Their results have been interesting, but of practical value only in limited fields. The consensus of opinion to-day appears to be that if the seven lens aberrations could but be expressed in a suitable mathematical language, they would assume comparatively simple forms readily soluble. It is quite certain, however, that such simplicity is impossible in any of the mathematical systems yet tried, and that the desired result will only be possible in some system not yet invented.

Our next greatest needs in lens design are generalizations and publicity. In every complete set of calculations for a given lens, conclusions are arrived at relating changes in radii, thicknesses, separations and glass indices to variations in the degree of correction, in other words, a set of differentials is obtained, by the laborious methods of ray triangulation. Yet these very valuable results are regularly allowed to go either to the waste basket or to the locked notebook. The renowned Abbe set a worthy example of world-wide usefulness by having prepared and published tables for the selection of companion glasses for telescope objectives, thereby saving others hundreds of hours of labor. If we followed his worthy example, we should publish sets of differentials applicable to each of the important lens types as soon as obtained and thus obviate a tremendous waste of time in duplicating results.

In particular, we need publication and public discussion of such material as general rules for the spectral correction of objectives for photographic and visual purposes, general rules for reducing distortion, for locating and displacing Gauss points, limits of tolerance in definition and resolving power, the best methods of testing objectives and the like.

In the design of optical instruments a similar lack of coordination and generalization is apparent. The instrument-using public has been too often ignorant and always tolerant of defective design. The average user accepts without question, as he is without recourse, instruments hastily conceived and imperfectly worked out in design. Our largest makers employ specialists in the design of each class of instruments. Lesser makers of the less used instruments, such as spectroscopes, photometers and radiometers, seldom have the benefit of the crystallized general opinion of those users of his instruments who know what the performance of a first-class instrument should be. We trust that every class of both user and designer of optical instruments will derive benefits from this organization.

No optical instrument can be of any service without either an eye or a photographic surface as an adjunct. The properties of these should, therefore, be well known to the designer of lenses and instruments as well as to those more directly interested in them. The material of these three chief branches of applied optics (lens design, vision and photography) is, however, widely scattered and few who are well posted in one branch are even well informed in the other two.

The fundamental problem of the photographic surface is the rendering of the light impressed upon it. The quantitative relations between exposure, development and

density of image were obtained by Hurter and Driffield twenty years ago. Since that time much has been found out concerning the nature of the latent image and of development and the conditions which govern speed and density gradient. The greater part of the preliminary work in photographic research may be regarded as complete.

Investigation in photography is now centered upon the more recondite problems and a clearing up of the nature of the photographic processes. We are not yet able to express photographic density as a function of energy, wave-length and time. The relation between plate speed and wave-length is known for but few emulsions. Speed varies with both absolute intensity of radiation and the rate at which it is applied according to laws not yet understood. The maximum density gradient obtainable varies with exposure, wave-length, emulsion and development in ways now being investigated. A knowledge of the resolving powers of the photographic surface, of the eye and of the lens or optical instrument is of the utmost importance to workers in almost every line of applied optics.

The photographic emulsion is optically a translucent medium of high scattering power. The penetration of light into such media varies a great deal with the wave-length of the light, with size of grain and with distance and direction in the medium. Hence, a knowledge of the optical laws governing scattered light is of the utmost importance in photographic research and of such laws but very little is known.

The photographic reactions to light bear a close resemblance in many respects to the reaction of the retina and from the optical properties of the retina much information may be drawn that throws light on the photographic effects and vice versa. Hence, the investigation of the retinal and photographic reactions may very properly be carried on side by side and results obtained in either field applied in the other.

Intimately related to all branches of applied optics are the visual properties of the human eye. Broadly stated, what is known of the eye as an optical instrument constitutes but a rough working knowledge of it. The curvatures, thicknesses and refractive indices of the various eye media in an average normal eye are fairly well known as well as the location of the nodal points and center of rotation. Three of the third order aberrations are important in vision, namely, the spherical aberration, the chromatic variation of the spherical aberration and the axial chromatic aberration. Of these only the last has been studied and measured and that only recently. One remarkable result of these measurements is the discovery that many eyes possess a type of axial chromatic correction previously unknown in lens optics and which probably could not be duplicated in a glass lens. It is to be hoped that methods of measuring the two other aberrations will shortly be devised and applied.

The nature of the reactions of the retina to light have been extensively studied during the last twenty years. But the problems requiring investigation are many and difficult and scarcely more than preliminary results have yet been obtained. The visual impression requires time to originate and grows at a rate varying with both the intensity and wave-length of the light producing it as well as with the previous treatment of the retina. It is no simple matter to isolate and measure these various effects nor to correctly interpret the results obtained.

Most studied and best known is the relative brightness of the same amount of radiation of various wave-lengths, the so-called "Visibility" of radiation. This is a measure of the relative sensibility of the

retina to light of different wave-lengths but of equal energy. This relation is known for a great number of subjects to a quite satisfactory precision. It establishes the ratio of the light unit to the energy unit, hence, is of fundamental importance in illuminating engineering. Strictly speaking, we can neither define nor measure light without it.

When it comes to measuring the light sensation caused by a given light impression, an apparently insurmountable difficulty is encountered, for a sensation can not be directly measured. The sensation is, however, the integral of the sensibility and the sensibility is proportional to the reciprocal of the just noticeable difference in intensity and this may readily be measured. The necessary data are being accumulated and before long we shall be able to formulate the general laws of the visual reaction to light intensity in the case of white light. Similar data relating intensity sensibility to color, intensity and time must next be obtained.

On entering a dark room we become able to distinguish objects after a shorter or longer interval of time depending upon various conditions not yet worked out. Rate of adaptation curves must be determined for all initial conditions of adaptation, not only for white light but more particularly for the reds, yellows and greens used in the safe lights of dark rooms.

Very little is yet known of the relation between visual acuity and the brightness of the object viewed. The ability to distinguish fine details is known to fall off rapidly with decreasing illumination, but we have not the data for the formulation of any laws.

Illuminating engineers require a mass of such data on the properties of the retina, for the eye is the sole means of judging whether lighting is good or bad and the conditions for best seeing have been only very roughly worked out thus far. We require to know what illumination levels and what contrasts are best and what are the effects of excessive contrasts and oblique glare in depressing the sensibility of the retina.

The precise measurement of color is an almost unworked but important field of applied optics. The preliminary part of the work only has been done. The underlying theory has been roughed out, methods have been devised and precision colorimeters designed. But our fundamental color scales have been but partly worked out and the various laws of color combination are practically unknown. The work urgently requiring attention in this field amounts to quite a number of man-years.

Within the necessary limits of this discussion only the more urgent problems in the more important fields of applied optics could be reviewed. The special problems of refractometry, photometry, radiometry, interferometry, spectrophotometry, polarimetric analysis and other fields can not even be enumerated here. It is hoped, however, that this brief outline may have impressed upon us all the necessity for concerted effort in solving the numerous problems which confront us. We trust that the formation of this society will, by promoting team work and well directed research, prove to be a powerful factor in the advancement of applied optics. This city has long been a leader in the production of optical materials, may it become the great source of optical ideas and the recognized home of optical learning.

P. G. Nutting

SCIENTIFIC NOTES AND NEWS

Dr. William W. Keen has been reelected president of the American Philosophical Society for 1916. The vice-presidents, Professors William B. Scott, Albert A. Michelson and

Edward C. Pickering have also been reelected.

PROFESSOR R. A. MILLIKAN, of the University of Chicago, was elected president of the American Physical Association at the recent Columbus meeting.

THE officers of the American Society of Naturalists for 1916 are: *President,* Raymond Pearl; *vice-president,* Albert F. Blakeslee; *secretary,* Bradley M. Davis; *treasurer,* J. Arthur Harris; additional members of the *executive committee,* Edward M. East, Henry V. Wilson, Frank R. Lillie. The society has ordered an appropriation of $200 for the Concilium Bibliographicum, Zurich.

NEWS has been received from Sweden that the actual delivery of the Nobel prize in chemistry for 1914, awarded to Professor Theodore W. Richards, of Harvard University, together with the other Nobel prizes for 1914 and 1915, will be postponed until June 1 of this year. The prize-winners are invited to go then to Sweden in person to receive their prizes, and to give their Nobel lectures.

THE Leeuwenhoek medal of the Netherlands Academy of Sciences, awarded to Surgeon-General Sir David Bruce, F.R.S., A.M.S., was presented to him on December 24 by the Netherlands Minister to Great Britain. The medal was founded in 1875, on the occasion of the Leeuwenhoek celebration in Delft, and is presented every ten years. It was awarded to Ehrenberg in 1875, to Ferdinand Cohn in 1885, to Louis Pasteur in 1895, and to Beyerinck in 1905.

DR. LAZARUS FLETCHER, F.R.S., director of the Natural History Departments of the British Museum, has been knighted.

PROFESSOR IRVING PORTER CHURCH will retire from the faculty of the college of civil engineering of Cornell University at the close of the current academic year, when he will be sixty-five years old. The board of trustees has adopted a resolution expressing its sense of the university's debt to Professor Church.

PROFESSOR C. FRANK ALLEN, who has held the chair of railroad engineering in the Massachusetts Institute of Technology since 1887, will retire under the benefits of the Carnegie Foundation at the close of the present academic year.

PROFESSOR R. B. CLINTON, who lately retired from the professorship of experimental philosophy at Oxford at the end of his fiftieth year of service, has been elected to an honorary fellowship at Wadham College.

THE Draper Committee of the National Academy of Sciences has granted $300 to Professor Joel Stebbins, head of the department of astronomy of the University of Illinois, in support of his researches at the observatory. The special work which is now being carried on at the observatory is the improvement of his method of measuring the light of stars, which is being developed in collaboration with Professor Jacob Kunz of the department of physics.

AT its meeting of January 12, the Rumford Committee of the American Academy of Arts and Sciences appropriated the sum of $200 to Professor H. M. Randall, of the University of Michigan, in aid of his researches on the infra-red spectrum, the grant to be used to defray the salary of an assistant.

DR. WILLIAM DEB. MACNIDER, professor of pharmacology at the University of North Carolina, has been notified of an award of $250 by the trustees of the Rockefeller Institute to enable him to continue his research work in pharmacology.

DR. FREDERICK E. DILLEY ('03, Western Reserve), instructor in surgery, Union Medical College, Peking, China, has arrived for postgraduate work in Cleveland until next August.

DR. KARL H. VAN NORMAN, formerly of the Johns Hopkins Hospital and now a captain in the Royal Canadian Army Medical Corps, is in charge of a British hospital division at Ramsgate, England.

DR. HUGH M. SMITH, commissioner of fisheries, was elected honorary president of the Washington Aquarium Society at an organization meeting held on January 21. Other officers elected were: *President,* Dr. R. W. Shufeldt; *First Vice-president,* L. W. Bauer; *Second Vice-president,* Mrs. L. Helen Fowler;

Corresponding Secretary, J. Henri Wagner, and *Financial Secretary* and *Treasurer,* E. S. Schmidt. The following committee was elected to prepare a constitution and by-laws: Dr. Paul. Bartsch, chairman, Miss Mary C. Breen, Mrs. G. H. Burris, W. S. Adams and J. E. Benedict.

An intensive study of the question of pneumonia will be made by a commission appointed on January 11, by Director Wilmer Krusen, of the Department of Health and Charities of Philadelphia. The recent epidemic of grip and pneumonia occasioned the appointment of a commission. Director Krusen appointed the members from those eminent either for clinical work or for their ability as laboratory research workers. The city laboratories will be placed at their disposal. Dr. David Riesman, professor of clinical medicine in the University of Pennsylvania and the Philadelphia Polyclinic, will be chairman. Other members are: Dr. Hobart A. Hare, professor of therapeutics at Jefferson Medical College; Dr. Judson Daland, professor of clinical medicine in the Medico-Chirurgical College; Dr. William Egbert Robertson, professor of the practise of medicine, Temple University; Dr. Randle C. Rosenberger, professor of hygiene and bacteriology in the Jefferson Medical College and the Women's Medical College; Dr. Paul A. Lewis, director of the Ayer Clinical Laboratory of the Pennsylvania Hospital and director of the pathological department of the Henry Phipps Institute, and Dr. John A. Kolmer, professor of pathology, Philadelphia Polyclinic; instructor of experimental pathology at the University of Pennsylvania.

The mental hygiene committee of the New York State Charities Aid Association announces that, in the interest of a state-wide campaign of education for the prevention of insanity, plans have been made for public lectures. Specialists in mental diseases have been appointed to deliver such lectures, including Drs. Stewart Paton, Smith Ely Jelliffe, August Hoch, Thomas Henry Williams, Menas S. Gregory, Charles S. Little, Thiells, William Mabon, James V. May and Herman G. Matzinger.

At the recent biennial convention of the honor society of Phi Kappa Phi, the following officers were elected: *President General,* Edwin E. Sparks, State College, Pa.; *Secretary General,* L. H. Pammel, Iowa State College, Ames; *Treasurer General,* C. H. Gordon, University of Tennessee, Knoxville; *Registrar General,* J. S. Stevens, University of Maine, Orono; *Provincial Secretaries:* Eastern District, J. A. Foord, Massachusetts Agricultural College, Amherst; Southern District, G. H. Boggs, Georgia School of Technology, Atlanta; Northern District, E. N. Wentworth, Kansas Agricultural College, Manhattan; Western District, L. W. Hartman, University of Nevada, Reno. The constitution was revised and other important business was transacted.

Dr. Willis T. Lee, of the U. S. Geological Survey, is giving a course of ten lectures at the Johns Hopkins University on successive Monday and Tuesday afternoons. His subject is "Mesozoic Physiography of the Southern Rocky Mountains."

In the new Bowdoin Union, Bowdoin College, not yet dedicated formally, the first public lecture was given on January 17 by Professor George H. Parker, of Harvard University, who gave an illustrated address on "The Seals of the Pribiloff Islands," under the auspices of the Biological Club.

Dr. K. George Falk, of the Harriman Research Laboratory of the Roosevelt Hospital, delivered a lecture on "The Electron Conception of Valence," before the Chemical Society of the College of the City of New York on December 22.

Dr. Charles H. T. Townsend gave an illustrated lecture on verruga to the students of the medical school of Howard University, Washington, D. C., on January 15.

A memorial of Eustachius was recently unveiled in the great quadrangle of the University of Rome in the presence of the prime minister, the minister of public instruction, the mayor of Rome, and the rector and mem-

bers of the senate of the university. The memorial, which is a bronze tablet attached to one of the pillars of the upper portico, near a marble memorial of Victor Emanuel II., represents Eustachius in his professor's robes in the act of lecturing; he holds in his left hand a human skull and the right arm rests on tables showing the structure of the ear.

JOHN OREN REED, professor of physics in the University of Michigan, and until a year ago dean of the college of literature, science and arts, died on January 23, at the age of sixty years.

CHARLES VICTOR MAPES, an industrial agricultural chemist of New York City, died on January 23, in his eightieth year.

DR. ALFRED J. NOBLE, superintendent of the Michigan State Hospital in Kalamazoo, an authority on insanity, died on January 20, aged fifty-eight years.

THE death is announced at the age of forty-nine years of Professor Donaldson Bodine, who held the chair of geology and zoology at Wabash College.

MR. A. D. DARBISHIRE, lecturer on genetics in the University of Edinburgh, known by his experiments bearing on the laws of heredity, and his book on "Breeding and the Mendelian Discovery," died on December 26, 1915.

MR. H. A. TAYLOR, a distinguished English electrical engineer, known especially for his work on submarine cables, has died at the age of seventy-four years.

DR. FRITZ REGEL, professor of geography at Würzburg, died on December 2, aged sixty-two years.

DR. GEORGE OLIVER, an English physician, known for his valuable researches on the circulation of the blood, has died at the age of seventy-four years.

THE ninth annual meeting of the Illinois Academy of Science will be held at the University of Illinois, Urbana, Friday and Saturday, February 18 and 19, 1916. The program will be as follows:

Friday, 1 o'clock P.M.—Meetings of all committees.
Friday, 2 o'clock P.M.—Business and symposium on astronomy.
Friday, 6 o'clock P.M.—Dinner. Ten minute address upon the work, policy and value of the academy.
Friday, 8 o'clock P.M.—President's address and reception.
Saturday, 9 o'clock A.M.—General papers and sectional meetings.
Saturday, 12 noon—Luncheon.
Saturday, 1:30 o'clock P.M.—Inspection of the university buildings.
Saturday, 2:30 o'clock P.M.—General papers, election of officers and other business.

If papers presented render it advantageous, the academy will be divided into the following sections: (1) astronomy, mathematics, physics; (2) bacteriology, botany; (3) zoology, physiology, medicine; (4) chemistry, agriculture; (5) geology, geography; (6) archeology. The following are the Urbana committees: Hotels, Professor S. A. Forbes, chairman; Local Arrangements, Professor G. D. Beal, chairman; Entertainment, Professor C. R. Richards, chairman; Publicity, W. H. Stoek, chairman; Papers, W. S. Bayley, chairman.

ON January 7 and 8, a number of professional geologists of the southwest met at Norman, Oklahoma, for a two days' conference. The conference was called for the purpose of presenting and discussing various topics of interest to those geologists engaged in the petroleum industry. The conference was attended by forty visiting geologists and fifty major students and members of the faculty of the department of geology of the University of Oklahoma. The meeting was presided over by Charles H. Taylor, head of the department of geology of the University of Oklahoma, who was responsible for calling the conference. A number of profitable papers were read. Dr. van Waterschoot van der Gracht, director of the Netherlands Geologic Service, presented a paper on the Salt Domes of Northern Europe. Mr. E. L. DeGolyer, chief geologist for the Pearson Syndicate, presented a paper on the geology of Northwest Texas. Mr. A. W. McCoy, instructor of geology at the University of Oklahoma, read a paper on Capillarity Underground. Other geologists who appeared on the program were Dr. J. A. Udden, director of Texas Geological Bureau; C. W. Shannon,

director of the Oklahoma Geological Survey; R. A. Conkling, chief geologist, Roxana Petroleum Company; L. E. Trout, chief geologist, Maryland Oil Company; C. N. Gould and Harper McKee, consulting geologists; and M. G. Mehl, W. C. Kite and Charles H. Taylor, of the department of geology, University of Oklahoma. Much interest was shown in the reading and discussion of these papers. No organization was formed, but Professor Charles H. Taylor and Director C. W. Shannon were elected a committee to arrange for another similar meeting to be held at Tulsa, Oklahoma, at some future date.

The London correspondent of the *Journal* of the American Medical Association writes that the British authorities have decided that students in the fourth and fifth years of study should complete their course as rapidly as possible but that students in the first, second and third year should join the army. The effect of recruiting is shown by the statistics of ten leading medical schools, in which, during the first year of the war, the number of students was 1,891, as compared with the normal number of 2,562. The number of medical students who have entered Cambridge University this year is forty-one, as compared with 116 in the year 1913. The director general of the Army Medical Corps has asked for an additional 2,000 physicians before Chrismas for war service. The casualty lists of one week show the names of fifteen physicians, and the obituary lists of physicians killed usually three or four. Sir D. Macalister, in his presidential address at the opening of the present session of the General Medical Council, said that within the next few months every qualified man of suitable age who was fit for the work of an officer in the medical corps would be needed. From the British dominions and from other countries over 240 physicians had been registered this year, and when certain reciprocity arrangements had been completed, the number from Canada would be considerably increased. Although the War Office authorities recognized that the withdrawal from professional instruction of large numbers of medical students, of the first years, would have a serious effect on the future, they had deemed it inadvisable to discourage junior students who offered themselves for combatant service. The result of medical students accepting commissions and enlisting was that the prospective shortage of 250 qualified practitioners per annum, which he had mentioned on a former occasion as probable during the coming years, would almost certainly be exceeded. There was one direction in which it appeared likely some economy of medical students might be effected. The minor vessels of the fleets carried a surgical "probationer," and for this work medical students who had completed their physiologic and anatomic studies and had been instructed in surgical dressing are preferred. He was authorized to make it known that any "probationer," who after, say, six months' service, desired to present himself for a professional examination or to resume his studies, would be granted leave of absence or be demobilized, and a less senior student be appointed in his place. By such rotation of service, a succession of students might continue to be employed in war work and yet the qualification of none would be unduly delayed.

Nature says: "The accounts of the local committee of the Manchester meeting of the British Association, held in September, lately issued, show that the resolution to observe the strictest economy in view of the exceptional circumstances in which the meeting was held was faithfully kept, and the local officers are to be heartily congratulated on the success of their efforts in this as in other directions. The expenditure amounted to only £862 15s., and 22 per cent. was all that it was necessary to ask from the guarantors. On the occasion of the previous meeting, in 1887, the expenses reached £3,652, and 35 per cent. of the much larger guarantee fund was called up. The meeting was in every way a success; it was attended by many eminent scientific men, the papers and discussions were of high value, and the arrangements gave such satisfaction that at the concluding meeting of the general committee many influential members expressed the hope that future meetings might be "run" on the same lines, excluding much of the lavish

and costly expenditure on entertainments and excursions.

UNIVERSITY AND EDUCATIONAL NEWS

ANNOUNCEMENT of a gift of $250,000 for a library for Amherst College was made at the annual banquet of the Amherst Alumni Association of New York. The library is to be a memorial to a graduate of the class of 1867 from a brother whose name is withheld.

A GIFT of $150,000 from a graduate of Wellesley College toward the fund for a new administration building is announced. The donor does not wish her name made known at this time.

PRELIMINARY plans for the chemistry building at Throop College of Technology, in Pasadena, have been completed, and the architects, Mr. Elmer Grey, of Los Angeles, and Mr. Bertram G. Goodhue, of New York City, are at work on the complete detailed plans and specifications of the building. The building is to cost $60,000 and construction will be begun probably within thirty days. The building is to be ready for occupancy next September, and Dr. Arthur A. Noyes will inaugurate his research work in the new laboratory about December, 1916. He has just returned to Boston after a few weeks' stay in Pasadena, which time was spent in working out plans for the building, and for the development of the department of chemistry, and the special research laboratories.

IT is announced that a group of prominent dentists of New York City some months ago submitted to Columbia University a detailed proposal to create a dental school. The proposal has the approval of the faculty of the college of physicians and surgeons. Candidates for admission would be required to possess the same academic training as students entering the study of medicine at Columbia, namely, the completion of two years of work in an undergraduate college.

DR. J. T. KINGSBURY, president of the University of Utah, has presented his resignation to take effect at the end of the present academic year. It will be remembered that the administration of the University of Utah, which led to the resignation of seventeen members of the faculty last spring, has been reviewed and criticized in a report of a committee of enquiry of the American Association of University Professors.

DR. KATE GORDON, head of the department of education, Bryn Mawr College, goes next September to the Carnegie Institute of Technology, Pittsburgh, where she will have charge of the Bureau of Mental Tests and give instruction in psychology in the woman's department of the School of Applied Design.

AT Yale University, Henry Laurens, Ph.D., has been promoted to an assistant professorship of biology in Yale College.

DR. V. E. EMMEL, of the Washington University Medical School, St. Louis, Mo., has been appointed assistant professor of anatomy in the University of Illinois college of medicine, Chicago, Ill.

DISCUSSION AND CORRESPONDENCE

INSECTS IN THEIR RELATION TO THE CHESTNUT BARK DISEASE

A RECENT bulletin[1] of the Department of Forestry of the commonwealth of Pennsylvania discusses the relation of insects to the bark disease. This paper bears the title, "Insects as Carriers of the Chestnut Blight Fungus," and as such tabulates a number of insects collected and found carrying spores of this parasite. Tests were made on some seventy-five insects representing about twenty-five species. Of these, fifty-two were collected while on chestnut blight cankers. From these experiments it was found that thirty per cent. of these insects carried numbers of the pycnospores of this fungus on their bodies and that the highest counts by far were obtained from the spore-feeding longicorn beetle *Leptostylus macula* Say.

The citation of these results as proof merely that insects are carriers of the chestnut blight spores is entirely justifiable, but in drawing

[1] Studhalter and Ruggles, Bull. 12, Dept. Forestry, Commonwealth of Pennsylvania, 1915.

their conclusions the authors make the statement (p. 28) that

> they (*i. e.*, some insects) are important agents in the local dissemination of this disease. This is especially true of the beetle, *Leptostylus macula*.

They also dispute the conclusion reached by the writer[2] that *Leptostylus macula* is a more important factor in destroying the spores of this disease, and state (p. 20) that

> the large number of spores carried by this beetle certainly indicate that it may be an important agent in the dissemination of the blight fungus.

In the writer's opinion these statements lack proof. From the fact that the insects have spores on their bodies the conclusion can not be drawn that they disseminate the disease. It is shown that the spores may be brushed off from the bodies of the insects even though with difficulty, but the question is, Where are they brushed off? If the life histories and activities of many of these insects had been more carefully observed an opposite conclusion to that reached by the authors would appear to have been a more natural one. To disseminate this disease it would be necessary for the insect to migrate from infested to healthy trees. With most of the Coleoptera discussed in this publication this is not the normal habit.

In the case of *Leptostylus macula* it can be positively stated that under normal conditions this insect never frequents healthy trees. It must be admitted that in crawling from one canker to another for the purpose of eating pustules, this insect possibly would spread the spores to start a new infection on the same tree, but this would be insignificant in contrast to the fact that the rain, as stated (p. 23), washes these spores down the tree in large numbers.

The extent to which this, as well as certain other species, feeds on these fruiting bodies is illustrated by trees, examined by the writer, on which from 50 to 75 per cent. of the cankerous area was eaten clean of pustules. From such habits it would be natural to expect a far greater percentage of spores on this species than on others.

[2] Science, N. S., XXXVI., p. 825, 1912.

Of the three other species of beetles listed by the authors as carrying spores, all are known to feed on dead wood and therefore are not likely to frequent living trees. Of the thirteen ants collected under natural conditions and tested for spores, only three were found to carry those of *Endothia parasitica*. Ants frequent living trees, especially those infested by aphides, and in case they carry spores conditions would be favorable for infection of the wounds made by the aphides. But it is shown that only a small number of ants in nature were found to carry spores. Most of the other insects discussed may be considered as occasional visitors, such as those which rest on the trees between flights; of these, few are recorded as carrying spores. The only other insects discussed that might possibly be responsible for direct transmission of the disease are tree-hoppers, which might infect the wounds they make while ovipositing.

In discussing the dissemination of other fungous and bacterial diseases by insects (pages 7–11) the authors cite cases in which a direct relation between host and insect can be established, as fire blight of pear, spread from blossom to blossom by pollen-bearing insects, and by aphides which puncture the living tissue; and ergot of rye, where the insects are attracted by a saccharin solution oozing from the conidia-bearing surface. In discussing the chestnut insects the authors establish no such relation; in fact, the most important insects, in the writer's estimation, in which some such relation might be proven are not mentioned in their experiments. The first of these insects in importance is the longhorned beetle *Leptura nitens*, which bores in the bark of 90 to 95 per cent. of the living trees over 10 inches in diameter throughout the chestnut range and in addition has adapted itself for breeding in great numbers in chestnut blight cankers. The interrelation thus established by the beetle between the living, healthy trees and the cankers on diseased and dead trees would provide favorable conditions for the transmission of the disease. The adaptation of this beetle to life in chestnut blight cankers has become so marked in old infected tracts that it

has often been difficult to find the larvæ in healthy trees, although they were present in greatly increased numbers in the cankers. Thus this insect, which is undoubtedly of importance as a carrier of spores to healthy trees, would, as the infections grew old, become less so owing to its increasing tendency to breed in and frequent diseased trees to the exclusion of healthy ones. Other insects which come in this category are several species of moths of the genus *Sesia,* although, in the case of these, observations indicate that adaptation to a life in cankerous tissue has not developed to so great an extent.

Of more importance in providing for the spread of the chestnut bark disease are the fresh wounds made by certain insects through the outer bark of the tree to the cambium whereby spores disseminated in various ways can gain entrance. Of first rank among insects which work in this way are *Leptura nitens,* which, as stated, is found in 90 to 95 per cent. of the trees over 10 inches in diameter throughout the chestnut range, and the chestnut bast-miner *Ectoedemia phleophaga* Busck, which is found abundantly in 95 per cent. of the saplings and younger trees throughout the natural range of the chestnut. Less abundant, though also widely distributed, are three species of *Sesia—S. castanea* Busck, *S. scitula* Harris, and *S. pictipes* G. & R. All these insects attack perfectly healthy trees and make wounds at various situations over the entire bark surface of trees from those of sapling size to those which are matured. Furthermore, most of them are abundant and widely distributed. These wounds are all holes made by the larvæ either for the extrusion of frass—in which case they are present and used throughout the entire larval life—or for exit when the larvæ are preparing to leave the open to the cambium and surrounded by the moist dead tissue necessary[3] for the growth of the spores. Thus practically all chestnut trees in their natural range have numerous open wounds whereby wind-blown and rain-washed spores can gain entrance. Young cankers have been found starting in wounds of both types mentioned.

Wound makers of another class are the cicadas, tree crickets, tree-hoppers and aphides. These puncture the bark in ovipositing or feeding. In numerous cases the blight has been found starting in cicada and tree-hopper wounds. A possibility exists that these insects both carry the spores and directly inoculate the wound; but such a chance is slight from the fact that insects of this kind normally frequent healthy trees.

In conclusion it may be said that in view of the facts established, namely, that ascospores are carried about by the wind in great numbers and that the pycnospores are washed down the trunks by the rain, the rôle played by insects in the transmission of this disease in merely transporting the spores is insignificant. On the other hand, owing to these same characteristics of the disease, the part played by insects in making wounds in the living cambium where such spores can gain entrance is far more important, and such wounds have been commonly found infected. Again, the fact that certain insects frequent diseased trees and eat the pustules, thereby preventing the dissemination of the spores, can certainly not be considered other than a benefit.

F. C. CRAIGHEAD

BUREAU OF ENTOMOLOGY,
U. S. DEPARTMENT OF AGRICULTURE

[3] Rankin, W. H., "Phytopathology," Vol. 4, p. 242, 1914.

CANCER AND HEREDITY

IN final reply to Dr. Little, of Harvard, there are three things to be said:

I

My results in cancer transmission are these:

1. The establishment of strains of mice which both in inbreeding and in hybridization transmit spontaneous cancer through as many generations as I please to carry it, and in a percentage which can be predicted with a surprising nicety. For example, certain strains of mice have been producing a fairly steady percentage of spontaneous cancer in this laboratory for five years without a break.

2. I have taken strains riddled with cancer and by the type of breeding tests described in my published work have eliminated the disease absolutely from the strain and its hybrids.

3. A mass of data still unpublished shows that these things can be done not only with cancer in general, but also with cancer of specific organs and of specific types.

The persistent criticism of my "unorthodox" results in *color transmission* in this hallowed cross between an albino and a house-mouse only serves to confuse the issue with regard to the question of cancer inheritance; and if Dr. Little wishes to criticize my cancer work further, in the interests of logic I ask him to do so on the lines of my cancer work and not on the basis of color transmission.

II

It is impossible to agree with Dr. Little that any reference to "the great laws of heredity" must necessarily refer only to Mendel's laws, since every student of genetics knows that there is a vast array of facts of heredity which by no possible compression can be forced within the limits of these laws. Especially does every worker with the coat colors of mice know this fact. Perhaps an amendment may in time be added to those theories now supposed by Dr. Little to be a closed issue like the Koran.

III

The publication of my results in color transmission will be attended to in due time. These data belong with a mass of facts collected in the study of the inheritability of coat pattern. It would be impossible to get this material in form for immediate publication without seriously neglecting experiments now under way in the study of cancer.

Maud Slye
The Otto S. A. Sprague Memorial Institute

A MOLLUSK INJURIOUS TO GARDEN VEGETABLES

During the past summer a small slug or *Limax* was noted to be injuring garden vegetables of several kinds. It seemed rather large for the common *Agriolimax agrestis* (Linné) and specimens were submitted to Dr. H. A. Pilsbry for an opinion. They were found to be this species. Both underground vegetables and the leaves of the plants were attacked. In Canandaigua they were observed to attack potatoes, the mollusk frequently eating a hole in the tuber as large as its own body. As many as a dozen potatoes were observed to be thus eaten. In the same garden this slug attacked the string beans, eating into the full pods and consuming the beans. In Rochester, a garden was examined in which the potatoes were affected in the same manner as those at Canandaigua. In Syracuse, this slug was observed in cauliflower, in company with the smaller black slug, *Agriolimax campestris* (Binney). Some lettuce was also eaten by these mollusks. It is probable that this slug (*agrestis*) may become a pest in some localities.

Agriolimax agrestis is very abundant about Syracuse, in the east end, the hill portion, where one may see dozens of the slugs crawling on the sidewalk after a rain in a manner similar to the earthworms. This is particularly true on Euclid Avenue, where the morainic hills border the sidewalk on the south side. This brown slug as well as its smaller black relative is abundant in the woods and fields in and around Syracuse.

Frank Collins Baker
New York State College of Forestry,
Syracuse University

SCIENTIFIC BOOKS

La Science Française. Librairie Larousse, Paris, 1915. 2 Vols. Pp. 396 and 403. Illustrated with portraits.

The dominance of German science during our generation seems to have been rather generally accepted, a principal cause of which is clearly seen in efficiency of organization essentially military in its nature. With attention now focused upon German efficiency, it is possible to discern certain elements of this success which before had been obscure. The systematic German mind, with its pertinacity and indefatigability of purpose, has found one of its expressions in the preparation of exhaus-

tive treatises for each branch of science, bigger and more comprehensive than any which had preceded them. Such treatises have been particularly full in their discussion of the work of German investigators, and the wide familiarity with the field of a science which results directly from successful compilation has yielded a type of authority quite distinct from, though often joined to, that which has been responsible for a great advance through original investigation. Those who have attended international congresses in some field of science have not failed to note that German delegates have been much the most strongly represented, whether the place of meeting were near or far from their native land, and that their papers presented at the meeting have been so coordinated as to produce a telling effect. In many cases provision has been made by the government for the expenses of professors who are in attendance upon such international meetings. It can hardly be doubted that German science has for these reasons been given a most favorable presentation before the representatives of other nations.

It is not impossible that the advantage of the German scientists due to their propaganda has been fully realized by the French nation; but in any case the new history of French science prepared by the Ministry of Public Instruction with special reference to the Exposition at San Francisco, has served well the purpose of revealing the high position of French science before the world, with the inevitable consequence of originality and initiative due to individualism as contrasted with organized group efforts. The two volumes serve to introduce the reader to a truly remarkable library covering the field of French science which was exhibited at the exposition. The collection was made up, on the one hand, of books yellow with age and, on the other, of those on which the ink is hardly dry. In the language of the general introduction by Lucien Poincaré:

"In these works of such varied date and such different aspects one finds concentrated, so to speak, the thought of an entire people; here is the essential part which France has brought to scientific progress; here is the display by the authors themselves of the great discoveries due to her creative genius.

"For each science the attempt has been made to trace the origin to the moment when in France an order of studies important by reason of the intellectual or moral profit which they have brought to the human race, was approached for the first time and became the object of researches systematically conducted. The desire has been to mark the origin, the point from which so many hardy explorers have gone out on the eternal voyage toward research and truth. There has been indicated along the path traced by their glorious efforts, the summits from which the new horizons have been descried. Finally, with some insistence there have been set forth those stations actually attained, to be surpassed by the labors of to-morrow through following directions which it was sought to make precise."

Each field of science has been treated by a master mind, and in no way can the high authority of the work be so well set forth as by a transcription of the tables of contents. The first volume, devoted to pure science, includes the following chapters: French Science at the San Francisco Exposition, by Lucien Poincaré; Philosophy, by Henri Bergson; Sociology, by Émile Durkheim; Educational Science, by Paul Lapie; Mathematics, by Paul Appell; Astronomy, by B. Baillaud; Physics, by Edmond Bouty; Chemistry, by André Job; Mineralogy, by Alfred Lacroix; Geology, by Emm. de Margerie; Paleobotany, by R. Zeiller; Paleontology, by Marcellin Boule; Biology, by Félix Le Dantec; Medical Science, by Henri Roger; Geographical Science, by Emm. de Martonne.

The second volume is devoted to the humanities, and includes the following chapters: Egyptology, by G. Maspero; Classical Archeology, by Max. Collignon; Historical Studies, by Ch.-V. Langlois; History of Art, by Émile Male; Linguistics, by A. Meillet; Hindu, by Sylvain Lévi; Chinese, by Ed. Chavannes; Greek, by Alfred Croiset; Latin Philology, by René Durand; Celtic Philology, by Georges Dottin; The French Language, by Alfred

Jeanroy; French Literature of the Middle Ages, by Alfred Jeanroy; Modern French Literature, by Gustave Lanson; Italian, by Henri Hauvette; Spanish, by Ernest Martinenche; English, by Émile Legouis; German, by Charles Andler; Juridical and Political Science, by F. Larnaude; Economics, by Charles Gide.

Each chapter is followed by a well-chosen bibliography of the great French works within its field, and the work is embellished by portrait illustrations, Pasteur having been selected for the frontispiece of Volume I., and Renan for Volume II. The press work, while without any luxurious quality, is dignified and in the best French taste.

Wm. H. Hobbs
University of Michigan

SCIENTIFIC JOURNALS AND ARTICLES

The December number (Vol. 22, No. 3) of *The Bulletin of the American Mathematical Society* contains: "Concerning absolutely continuous functions," by M. B. Porter; "On the representation of numbers in the form $x^3+y^3+z^3-3xyz$," by R. D. Carmichael; "On the linear continuum," by R. L. Moore; "A problem in the kinematics of a rigid body," by Peter Field; "Jules Henri Poincaré" (review of Enquête de "l'Enseignement Mathématique" sur la Méthode de Travail des Mathématiciens, second edition, and Lebon's Notice sur Henri Poincaré and Savants du Jour: Henri Poincaré, second edition), by R. C. Archibald; "Shorter Notices"; Breslich's First-Year Mathematics for Secondary Schools, by D. E. Smith; Braude's Coordonnées intrinsèques, by R. C. Archibald; Châtelet's Leçons sur la Théorie des Nombres, by E. B. Skinner; Salmon's Treatise on the Analytic Geometry of Three Dimensions, fifth edition, volume 2, by Virgil Snyder; Hermann Grassmann's gesammelte mathematische und physikalische Werke, Band 3, by E. B. Wilson; "Notes;" and "New Publications."

The January number (Vol. 22, No. 4) of the *Bulletin* contains: Report of the October meeting of the society, by F. N. Cole; Report of the twenty-seventh regular meeting of the San Francisco Section, by Thomas Buck; "Transformation theorems in the theory of the linear vector function," by V. C. Poor; Review of Hobson's John Napier and the Invention of Logarithms, 1614, and Gibson's Napier and the Invention of Logarithms, by R. C. Archibald; Review of Moritz's Memorabilia Mathematica, by R. C. Archibald; "Shorter Notices"; Hill's Development of Arabic Numerals in Europe, by D. E. Smith; Caunt's Introduction to the Infinitesimal Calculus, by T. E. Mason; Lenz's Die Rechenmaschinen und das Maschinenrechnen and Furtwängler and Ruhm's Mathematische Ausbildung der deutschen Landmesser, by E. W. Ponzer; Dickson's Algebraic Invariants, Borel's Leçons sur la Théorie des Fonctions, second edition, Bateman's Mathematical Analysis of Electrical and Optical Wave-Motion on the Basis of Maxwell's Equations, and Rutherford's Radioactive Substances and their Radiations, by R. D. Carmichael; "Notes"; and "New Publications."

SPECIAL ARTICLES

THE POISONOUS EFFECTS OF THE ROSE CHAFER UPON CHICKENS

Serious losses have occurred each year during June and early July, from chickens having eaten the rose chafers (*Macrodatylus subspinosus*). These losses have often been ascribed to various causes, but close observations have shown that the chickens are very fond of eating these insects in large numbers, and post-mortem examinations have revealed the presence of many undigested insects in their crops. The crops are usually so full as to give the impression that death had been due to a "crop bound" condition of the chickens. Some have also supposed that these deaths were due to a mechanical injury of the crop by the spines on the legs of the insects having punctured the lining of this part of the digestive system, while others have accounted for the death of these chickens by the rose chafers having bitten the crops.

A number of cases, some of which resulted

in the loss of several hundred chickens, were reported to the writer and experiments in feeding rose chafers to chickens were taken up at the Storrs Agricultural Experiment Station in 1909.

The deaths from this diet usually occurred in from nine to twenty-four hours after feeding. This led the writer to believe that undoubtedly death resulted from a cause other than a mechanical injury to the crop or "crop bound" condition. An extract was made from crushed rose chafers and distilled water, filtered, and fed to chickens in varying doses with a medicine dropper and this resulted in a great many deaths. Small chickens died in a few hours after feeding, older chickens of heavier weight when fed a small quantity of the extract lived but showed signs of poisoning; large doses resulted in their deaths. Mature hens did not die from the extract.

From 150 to 200 chickens have been fed either with the rose chafers or with varying strengths of the extract to determine the weight of the chicken killed by a certain amount of poison, also to determine the age limit of the chickens killed.

The results may be summarized as follows: 15 to 20 rose chafers are sufficient to cause the death of a chicken one week old. From 25 to 45 rose chafers are usually necessary to kill a three-weeks-old chicken. While some nine-weeks-old chickens have been killed by eating rose chafers, only one ten-weeks-old chicken was killed in these experiments. In the crop of this chicken there were 96 undigested rose chafers counted in post-mortem examinations.

The chickens feed upon the insects ravenously, being attracted by their sprawly appearance and usually within an hour after eating they assume a dozing attitude, later leg weakness shows and the chicken usually dies within twenty-four hours of having eaten these insects, or begins to improve after this time.

In less than five per cent. of the deaths convulsions occurred. Post-mortem examinations showed no abnormal condition of the organs. In order to exclude the possibility of arsenical poisoning due to the rose chafers having fed upon leaves that have been sprayed, tests were made by a chemist for arsenic, but no evidence of arsenic was found.

Intravenous injections were made in these experiments, extracts for injection being made from forty grams of rose chafers and sixty c.c. of a salt solution having a specific gravity of .9 per cent. This extract was put in a centrifuge for five minutes, the extract drawn off in a pipette and filtered in vacuo. Three c.c. of this extract were injected into a 690-gram rabbit intravenously and this died in six minutes. Another rabbit, weighing 1.435 grams, died in three and one quarter minutes after an injection of four c.c. A small 610-gram rabbit, when injected with two and one half c.c., died in fifty-five seconds after injection, and a large 1,450-gram rabbit died in two hours and thirty-five minutes after being injected with two c.c. Other rabbits were injected and killed by this extract, but further work needs to be done to determine what is a lethal dose for rabbits and experiments in feeding rabbits per os will be taken up next summer.

As nearly as the writer can determine, the rose chafers contain a neuro toxin that has an effect upon the heart action of both chickens and rabbits and is excessively dangerous as a food for chickens.

Owing to the fact that the insect feeds upon such a large number of plants, particularly on daisies, it seems essential that chickens be kept in mowed fields and away from yards having grape vines and any flowering shrubs during the month when the rose chafers are about, especially during years when rose chafers are particularly abundant.

GEORGE H. LAMSON, JR.
CONN. AGRICULTURAL COLLEGE,
STORRS, CONN.

THE AMERICAN SOCIETY OF ZOOLOGISTS

THE American Society of Zoologists held its thirteenth annual meeting jointly with Section F and in affiliation with the American Society of Naturalists, December 28, 29 and 30, 1915, in Townshend Hall, Ohio State University, Columbus, Ohio.

BUSINESS SESSION

New Members

At the session for the transaction of business, held on the afternoon of December 29, President Wm. A. Locy presiding, the persons who had been nominated for membership in the society and who were recommended for election by the executive committee, were duly elected. A list of the names of these newly elected members follows:

Leslie Brainerd Arey, Northwestern University Medical School, Chicago, Ill.

George William Bartlemez, University of Chicago, Chicago, Ill.

William John Crozier, Bermuda Biological Station, Agar's Island, Bermuda.

Rhoda Erdman, Yale University, New Haven, Conn.

J. F. Gudernatsch, Cornell University Medical School, New York City.

L. V. Heilbrunn, University of Chicago, Chicago, Ill.

Julian Huxley, Rice Institute, Houston, Texas.

Roscoe R. Hyde, State Normal School, Terre Haute, Ind.

Sidney I. Kornhauser, Northwestern University, Evanston, Ill.

George N. Papnicolaou, Cornell University Medical School, New York City.

Frank H. Pike, Columbia University, New York City.

William Albert Riley, Cornell University, Ithaca, N. Y.

Reynold Albrecht Spaeth, Yale University, New Haven, Conn.

Olive Swezy, University of California, Berkeley, Calif.

Morris Miller Wells, University of Chicago, Chicago, Ill.

J. E. Wodsedalek, University of Idaho, Moscow, Idaho.

Sewall Green Wright, Department of Agriculture, Washington, D. C.

Officers

The ticket agreed upon by the committee on nominations, appointed by President Locy and consisting of C. M. Child, George Lefevre and Raymond Pearl, was approved by the society and officers were elected as follows:

For president during the year 1916, D. H. Tennent.

For vice-president during the year 1916, Charles Zeleny.

For member of the executive committee to serve five years, R. P. Bigelow.

For member of the executive committee to take the place vacated by the president-elect, L. J. Cole.

Report of Secretary-Treasurer

Financial Statement:

Balance and Receipts

Balance on hand January 1, 1915	$689.15
Dues received from members during the year 1915	273.10
Interest on deposits in Title Guarantee and Trust Co.	30.56
Dividend on fund in Industrial Savings and Loan Co. from J. H. Gerould, trustee	15.00
Total	$1,007.81

Disbursements

2,028 stamped (2 c.) special envelopes ..	$43.32
605 stamps (2 c.)	12.10
Typewriting (circular letters, addresses, etc.)	19.15
Typewriter supplies	1.00
Express charges	5.69
750 Columbia clasp envelopes	6.75
350 copies printed list new members	19.33
700 copies blank due bills	3.00
350 copies proceedings 1914 meeting	13.98
350 copies announcements 1915 meeting.	7.10
1,000 nomination blanks	8.25
500 copies of program for 1915 meeting.	16.90
Expenses of Sec'y-Treas. at 1915 meeting.	41.56
Total disbursements	$198.13
Total amount received	1,007.81
Balance on hand Dec. 29, 1915	$809.68

Unpaid Dues

Number of members with dues in arrears:

For the years 1913, 1914, 1915...	1....	($3.00)
For the years 1914 and 1915 ...	12....	($24.00)
For the year 1915	41....	($41.00)
Total	54....	($68.00)

Section Established

For the information of the Society it was reported that a permanent Pacific Section of the American Society of Zoologists was organized last summer which cooperated with the American Association for the Advancement of Science in holding a successful zoological meeting in connection with the Panama Exposition in San Francisco.

Conflict between Zoologists and Naturalists in Time of Holding Meetings for Reading Zoological Papers

The secretary also reported that the executive committee has been unsuccessful in its attempt to arrange with the executive committee of the American Society of Naturalists a plan whereby the two societies will not schedule simultaneous sessions for the reading of papers of interest to members of both societies, and, after some discussion, the following motion by H. S. Jennings was passed by this society.

The society recommends to the executive committee the desirability of consulting with officers of the American Society of Naturalists, Section F, and the Botanical Societies, as to the formation of a union section for the presentation of papers in genetics and evolution, this section, if need be, to hold meetings parallel with those of other sections of the societies.

Committee on Premedical Education

A report from the committee on premedical education having been called for, H. B. Ward, chairman of the committee, explained satisfactorily the delay in presenting a report.

The society, after some discussion, expressed its hope that there will be a continuation of the discussion of the subject of premedical education between the committees appointed for this purpose by the American Societies of Zoologists and Anatomists, which will result in substantial agreement and a specific report.

Committee on Memorials

The committee appointed at the last annual meeting to prepare suitable memorials of Seth Eugene Meek and Charles Sedgwick Minot, deceased members, submitted the following, which were adopted and ordered to be placed with the minutes of this meeting and published with the proceedings.

Seth Eugene Meek

April 1, 1859—July 6, 1914

Dr. Seth Eugene Meek was born in Hicksville, Ohio, April 1, 1859, of Scotch parentage. He studied at Valparaiso University and obtained the degree of S.B. in 1881. Continuing his studies at the University of Indiana he received the degree of S.B. in 1884 and M.A. in 1886. He was a Fellow at Cornell University from 1885 to 1886, and was granted the Ph.D. degree from the University of Indiana in 1891.

He married Ella E. Turner, December 25, 1886. He held the following positions: Professor of natural sciences, Eureka College, 1886–1887; Coe College, 1887–92; assistant professor of biology and geology and curator of the museum, University of Arkansas, 1892–96; curator of ichthyology, Field Columbian Museum, 1897 until the time of his death. He studied at the Naples Laboratory in 1896–97, and was in the employ of the United States Bureau of Fisheries in the summers from 1887 to 1897.

He carried out numerous explorations for ichthyological data, especially concerning the geographical distribution of fishes in Canada, the central and western United States, Mexico, Guatemala, Nicaragua, Costa Rica and Panama. He acted as ichthyologist for the Biological Survey of Panama in 1911–12.

His scientific publications comprise over seventy papers, dealing largely with the taxonomy and geographical distribution of American fishes. His best work is probably that on the fresh-water fishes of Mexico and Central America; especially his memoir published in 1904 on the fresh-water fish of Mexico north of the Isthmus of Tehuantepec; besides dealing with the taxonomy this memoir contains an important analysis of the geographical distribution of fishes and includes descriptions of many new species. His previous work in Central America, especially in Guatemala and Nicaragua, had given a basis of experience which enabled him to speak with authority, and would, no doubt, if his life had been spared, have led to valuable generalizations upon geographic and faunistic problems.

He was a careful and enthusiastic worker, a man of genial temperament and slow to anger, cautious and judicial in his attitude on doubtful questions.

The American Society of Zoologists puts this minute on record, and expresses its deep regret at the too early loss of such an honored member.

Charles Sedgwick Minot

1852–1914

In the death of Dr. Charles Sedgwick Minot the American Society of Zoologists has lost a valued and honored member and science an able and trusted worker.

The society, therefore, desires to place on its records the following minute in recognition of his services to science and to mankind.

Born to leadership, with an unusual talent for organization, Dr. Minot took a leading part in the foundation of a number of societies for the advancement of biological research. Amongst these

was the American Morphological Society, the forerunner of the American Society of Zoologists, and in the year 1896–97 he was its president. Later, when his interests lay rather in the field of anatomy and medical education, his scientific work retained the character of its earlier days and still commanded the interests of the wider circle of biologists. From the very beginning of his career, his mind showed a grasp of the larger problems of science, and while accurate and painstaking to an unusual degree, his incisiveness of thought and expression, and his broad outlook stood out as his predominant characteristics. Ever ready to help with sound advice or arduous labor any enterprise for the advancement of his chosen field, he was not one to shirk the disagreeable duties of life or to gloss over with fine words things that were not right. He voiced his opinion courageously and effectively when occasion called, but his criticism, though keen, was constructive and his active cooperation was always welcome and often indispensable—a true and helpful comrade, a wise and fearless leader.

Propositions from Wistar Institute

After a general discussion of the following offer made by the director of the Wistar Institute, Dr. Milton J. Greenman, to the members of the society in order to secure more permanent support and general distribution of zoological journals published by the Wistar Institute—"*that we* (the Wistar Institute) *offer to members of the American Society of Zoologists, all issues of the Journal of Experimental Zoology* (two volumes per year, present price $10.00) *or all issues of the Journal of Morphology* (about one and one third volumes per year, price $12.00) *for $4.50 in yearly dues per member to be paid by the society*"—the society instructed its executive committee to secure, if possible, an offer more nearly the equivalent of that made to the membership of the American Society of Anatomists, subject, however, to modification such as to permit those members who are also members of the American Society of Anatomists, to secure for $4.50 the issues of the journal they do not receive by virtue of dues to the American Society of Anatomists, all other members to pay $6.50, through the American Society of Zoologists and receive all issues of four journals.

In case such an offer is secured, the executive committee was given power to increase the annual dues to $5.00 or $7.00, as the case may be, and to enter immediately upon such an agreement.

Fahrenheit Thermometer Bill

The question of passing a resolution favoring favorable action by congress upon the bill for abolishing the use of the Fahrenheit thermometer in government publications was presented and being informed by H. B. Ward that the advisability of passing such a resolution is being debated by the Physicists, within whose field the subject more properly belongs, the society decided to take no action.

Concilium Bibliographicum

The urgent need of the Concilium Bibliographicum for funds at the present time, due to conditions in Europe caused by the war, to enable it to continue its work, was presented by E. L. Mark, and upon his motion the secretary-treasurer was instructed to forward to the Concilium Bibliographicum, Zurich, Switzerland, from funds in the treasury the sum of two hundred dollars.

Invitation to Meet in Minneapolis

A cordial invitation from men of the various scientific departments of the University of Minnesota to meet at some time in the near future in Minneapolis was transmitted to the society through H. F. Nachtrieb. The secretary was instructed to bring this invitation to the attention of the executive committee, and the hope was expressed that the next meeting in western territory may be held in Minneapolis.

List of Officers and New Members

The secretary was authorized to print and distribute lists of officers and new members and to make such corrections to the list of members as may be necessary.

Sessions for Reading Papers

Sessions for reading papers listed on the program were held on the forenoon and afternoon of Tuesday, December 28, and on the forenoon of Wednesday, December 29. Vernon L. Kellogg, vice-president of Section F, presided at the session held on the afternoon of Tuesday; Wm. A. Locy, president of the Zoologists, presiding at all other sessions.

A list of the papers read in full or by title, together with abstracts of each paper, classified according to general subjects, follows:

ECOLOGY

The Effect of Certain Ions on Rheotaxis in Asellus (illustrated with lantern): W. C. Allee, Lake Forest College.

Of the kations tested, potassium and rubidium

alone cause a strong increase in the positiveness of the rheotactic reaction of the isopod, *Asellus communis* Say. Sodium has a similar but less pronounced effect. The efficiency of the chlorine salts in causing this change is:

$$Cs < Li < Na < Rb < K,$$

or, arranging in order of their chemical activity:

$$Li < Na < K > Rb > Cs.$$

The anions also affect the rheotactic reaction. In a series of potassium salts KCl gives the greatest increase in positiveness. The favorableness of the anions tested is:

$$Br, I, No_3 < CH_3Coo, < ClO_3 < SCN < Cl,$$

with chlorine much more favorable than its nearest competitor. The relative toxicity of neither the anions nor kations runs parallel with their relative effect on rheotaxis.

Any ion in the concentrations (usually $N/.5 - N/10$) used in these experiments will cause a decrease in the positive rheotactic reaction if allowed to act for sufficient time. Calcium almost always causes this depression without a preliminary increase. Strontium and barium act similarly, but magnesium often stimulates before depressing.

By alternating an isopod between $N/10$ solutions of KCl and $CaCl_2$ its rheotactic reaction has been alternately increased and decreased as many as seven times in the six hours before the animal succumbed to the treatment.

Negative isopods treated with KCl until strongly positive have their resistance to $N/400$ NaCN decreased, which indicates that their rate of metabolic activity has increased. $CaCl_2$ has exactly the opposite effect. These results support earlier work on the relation of rheotaxis and metabolism in *Asellus*.

Glacier Oligochæta from Mt. Rainier (illustrated with lantern): PAUL S. WELCH, Kansas State Agricultural College.

Mesenchytræus solifugus (Emery, '98; Moore, '99; Eisen, '05) and *Mesenchytræus niveus* (Moore, '99), found on certain Alaskan glaciers, are apparently the only recorded Oligochæta which normally inhabit snow and ice. Six collections, January 7 to June 17, 1915, from the snowfields and glaciers of Mt. Rainier, Washington, contain an undescribed enchytræid (*Mesenchytræus gelicus* n. sp.) which occurs abundantly in that very unusual habitat. Among the remarkable structural characters of this worm, the extent and complexity of the reproductive organs are perhaps most noteworthy. A pair of very large spermathecæ extends from IV./V. to XI., almost completely filling the cœlom, and containing surprising quantities of spermatozoa. A pair of well-developed sperm sacs, extending from XI./XII. to XXXV. and containing large masses of developing spermatozoa, are surrounded by a large ovisac which extends from XII./XIII. to XXXV. and contains in addition large quantities of developing ova. The penial bulb is very complex in organization. The specimens are very dark in color, due to the large amount of pigment in the hypodermis. Certain internal organs, especially the spermathecæ, chloragog cells and lymphocytes also contain pigment granules. The collections also contain specimens of *M. solifugus* Emery, a form which occurs in abundance on the permanent snow and ice fields of Mt. Rainier. Evidence points to certain snow algæ as one of the chief sources of food for both of these worms.

The Reaction of Fishes to Stimuli not Encountered in their Normal Environments: V. E. SHELFORD, Illinois State Laboratory of Natural History.

Wastes from the manufacture of illuminating gas are commonly thrown into streams and are probably more generally fatal to fishes than any other industrial wastes. In course of the investigation of the effects of products of the destructive distillation of coal upon fishes about twenty-five compounds have been studied. Nearly all are rapidly fatal when present in minute quantities. The reactions of fishes to these ingredients have been tested and the fishes tested are positive to fifteen of the twenty-five compounds, indefinite or indifferent to seven and negative to only two or three. Thus the reactions of the fishes are of such a nature as to destroy rather than to preserve them.

COMPARATIVE AND GENERAL PHYSIOLOGY

The Relation Between Wave-length and Stimulation in the Lower Organisms: S. O. MAST, Johns Hopkins University.

The relative stimulating effect of different regions of a spectrum having a known distribution of energy was ascertained for the following fifteen species: *Chlamydomonas, Trachelomonas* and *Phacus,* each one species; *Pandorina, Eudorina, Gonium* and *Spondylomorum,* each one species; earthworms, *Arenicola* (larvæ) and blowfly (larvæ) each one species.

The results obtained are briefly stated below

without corrections for the difference in the energy of these regions. They are, however, of such a nature that the corrections mentioned will not result in marked alterations.

For all but one of the microscopic organisms the results fall into two groups. In the one group the region of stimulation begins in the blue near the violet, between 430 $\mu\mu$ and 440 $\mu\mu$. From here toward the red end of the spectrum the stimulating efficiency rises, at first slowly and then rapidly, to a maximum in the green near the yellow, between 530 $\mu\mu$ and 540 $\mu\mu$; then it falls, at first rapidly and later more and more slowly, ending in the red at about 640 $\mu\mu$. In the other group the region of stimulation begins in the violet between 420 $\mu\mu$ and 430 $\mu\mu$, only a short distance from the place where it begins in the first group. From here the efficiency rises very rapidly, reaching a maximum in the blue between 480 $\mu\mu$ and 490 $\mu\mu$. It then falls rapidly and ends in the green in the neighborhood of 520 $\mu\mu$. Three of the microscopic forms, *Pandorina*, *Eudorina* and *Spondylomorum*, belong to the first group, the rest to the second. To this group belong also *Arenicola* larvæ and the earthworms. For the remaining microscopic form (*Chlamydomonas*) the maximum is in the green very near 510 $\mu\mu$; and for the blowfly larvæ it is approximately at 520 $\mu\mu$. The distribution in the spectrum, of stimulating efficiency is, for this creature, essentially the same as the distribution of brightness for color-blind persons.

These results show that stimulation in all of the organisms studied depends upon the wave-length of the light; that the stimulating efficiency is very much higher in certain regions of the spectrum than in others; but that the distribution of this in the spectrum differs greatly in certain organisms that are closely related in structure, *e. g.*, *Pandorina* and *Gonium*, while it is essentially the same in others that are very different in structure, *e. g.*, *Euglena* and earthworms. They also have a bearing on the nature of the chemical changes associated with the reactions to light.

Negative Orientation in Vanessa Antiopa: Wm. L. Dalley, Jr., Randolph-Macon College. (Introduced by S. O. Mast.)

Certain photo-positive insects orient, on coming to rest in direct sunlight, so that they face directly away from the sun. Is this phenomenon dependent upon previous violent exercises, as Professor Parker holds, and is it a reaction to light or to heat?

Vanessa, which has been raised in a small cage and had never flown in the open, repeatedly oriented negatively in sunlight, as did also specimens with both eyes covered so that no light could enter. Moreover, normal animals exposed in darkness to heat-rays from an electric flatiron usually face away from the source of heat, and they respond in the same way even when the heat-rays are opposed by light-rays coming from the opposite direction. Furthermore, when normal animals are placed in a room the temperature of which is high (29° C. to 32° C.) they do not orient at all, no matter how they are illuminated.

These results seem to show that when *Vanessa* faces away from the sun on coming to rest in sunlight, it is reacting to heat and not to light, and that this reaction is not necessarily dependent upon previous violent exercise.

Electric Currents Generated in the Eye of the Fish by Light: Edward C. Day, Syracuse University.

The live fish, wrapped in a wet cloth, gills irrigated by a hose led into the mouth, was placed in a dark box. Electrodes were applied to the eye, one to the cornea and one to back of eye-ball, and connected with string galvanometer. When light struck the eye the galvanometer recorded electrical disturbances. By projecting the shadow of the string into a photographic apparatus its deflections could be recorded along with time and exposure curves. On-effect consists of a slight depression *A*, followed by a strong abrupt elevation *B* and another slower secondary rise *C*. Off-effect consists of an abrupt elevation *D*.

For dark-adapted eye all four deflections are present; *B* is always greater than *D*. For light-adapted eye *A* and *C* are absent; *B* is smaller than *D*. Latent period from onset of light to beginning of $A = 0.032''$, $B = 0.075''$, $C = 1\text{–}7''$; and from extinction of light to beginning of $D = 0.05''$.

Deflections may be resultant expression of interfering reactions of three substances in the retina.

Intermittent stimulation gives oscillatory curve composed chiefly of *A* and *D* deflections; 25 flashes per second evoked 25 oscillations, and oscillations blended at 28 flashes per second.

Changes in Thelia bimaculata (Fabricius) Induced by Insect Parasites (illustrated with lantern): S. I. Kornhauser, Northwestern University. (Introduced by Wm. A. Locy.)

In *Thelia* pronotum covers entire body, extending far in front of head as a horn and back over thorax and abdomen. It is coarsely punctured

over entire surface, being in the male dark brown with large lateral spot (vitta) of bright yellow on each side, and in the female gray with only faint indication of vitta.

In parasitized males, color of pronotum corresponds to that of normal female. Not only is yellow lost from vitta, but characteristic pigment of female develops. Vitta of normal male is yellow because chitin is transparent (shows no melanin even in punctures), allowing a yellow hypodermal pigment (non-melanic and easily destroyed by acids and other organic solvents) to shine through. Punctures have no yellow pigment below them. In female vitta is gray because punctures are brown (due to melanin in superficial layers of chitin), and hypodermal areas are partially filled with grayish residue in cells and greenish pigment unevenly scattered. These female characters are assumed by fully parasitized males and the degree of change depends upon how long before its final moult the nymph was parasitized. Thus all intermediate stages of disappearance of yellow pigment and assumption of melanin have been found.

Normal female of thelia is larger than normal male; and abdomen and wings, less melanic. Measurements of pronota, wings and abdomens, show that parasitized males are larger than normal males, but not as large as normal females. There is also a reduction of melanin in abdomen and wings of parasitized males. Abdomen assumes pointed form of female, and posterior chitinous rings increase in length.

Internally, testes undergo fatty degeneration, and are finally entirely lost (either before or after final moult), although cell divisions (often abnormal) continue up to last vestige. Entire abdomen of male becomes crowded with fat, in which parasites are imbedded. Normally only female abdomen contains much fat, while that of male is almost entirely filled with testes, vas deferens and seminal vesicles. Assumption of female secondary characteristics by male must be due not only to loss of primary sexual organs, but also to changed metabolism (laying on of fat) caused by action of parasites themselves.

Differentiation and Dedifferentiation in Bursaria and its Significance: E. J. LUND, University of Minnesota.

During the process of regeneration of pieces of *Bursaria* a simplification of structure of the cut piece always takes place previous to differentiation. A similar process is evident during encystment and excystment, during normal division and sometimes periodically during the life of a normal individual.

The only conceivable ways, looked at from the standpoint of physical science, that "regulation," "regeneration," "making over," etc., of a complex structure can take place is: (1) (*a*) that it is first *simplified* physico-chemically to a greater or less extent; (*b*) that the products resulting from simplification are necessary and sufficient for the production of a different structure; (*c*) that these parts (resultant products, perhaps amino acids or simpler proteins, etc.) be capable of *recombination* in a *different* way, or (2) that a stereoisomeric change takes place in the system. But the latter is obviously insufficient to account for the changes actually taking place in regulating structures, and is not what would be expected from a knowledge of many chemical facts of metabolism. This statement of regeneration processes does not imply that antecedent properties which determine the specific path of differentiation (determiners of heredity) of the morphologically non-differentiated cell do not exist, nor that they are variable or invariable if they do exist.

Light Reactions of Diemyctylus: A. M. REESE, West Virginia University.

Diemyctylus is negatively phototropic to a marked degree at ordinary temperatures. At a temperature near 0° C. and at a temperature of about 36° C., it is more or less indifferent to light. The response is the same when the light comes from below.

It is positively phototactic to lights of all intensities, though this seems to vary with the different seasons. Experiments are now under way to determine this. At low temperatures the phototaxis may be inhibited or reversed.

It responds to red, green and blue lights as to white light, the response being less marked to green than to red, and still less to the blue.

Diemyctylus responds promptly to a spot of sunlight thrown upon various parts of the body by a small mirror, as has been noted by the author for *Necturus* and *Cryptobranchus*.

On Loss of Cell Pigment as an Index of Permeability Changes: W. J. CROZIER, Bermuda Biological Station.

Experiments with tissues of the nudibranch *Chromodoris zebra* give evidence showing that, at least in this case, which has the advantage of being uncomplicated by strong muscular contraction, the outward diffusion of cell pigment can not be used to estimate permeability increase quantitatively. The speed with which the pigment appears

outside the cell varies with the degree to which the tissue is stretched. In studying a large number of acids, no parallelism could be discovered between their rates of entrance into the cell and the order of pigment loss in the different acid solutions. Using the penetration time of acids as a criterion of penetrability (their entrance being shown by the color change of the pigment, which is a "good" indicator for acids), instances have been found in which the speed of acid penetration is accelerated, while loss of pigment is delayed, and, reciprocally, permeability toward acids may be caused to decrease while the pigment diffuses out of the cell.

The Doubtful Validity of the Hypothesis of Warning and Immunity Color: W. H. Longley, Goucher College.

This paper reports observations upon the color and color-changes of tropical reef-fishes of the West Indian region. The facts noted lead to the conclusions that the color of the fishes is very definitely correlated with their habits and that color-changes are adaptive. Of these ideas both seem incompatible with the conspicuousness hypotheses, but neither is at variance with the conception of concealing coloration.

Rate of Regeneration from New Tissues Compared with that from Old Tissues: Charles Zeleny, University of Illinois.

When a second removal of the tail of the frog tadpole is made at a level proximal to that of the first removal the tissue at the cut surface is the original old tissue. When the second removal is made distal to the first the cells at the cut surface are the newly regenerated ones. The levels of these cuts can be so regulated as to make possible a direct comparison of the rates of regeneration in the two cases. Such a comparison shows that there is no essential difference between the two rates, a slight advantage in favor of the regeneration from new tissues being probably not significant. In one of the experiments the specific amount of regeneration at the end of six days was .196 from old tissue and .204 from new tissue. At the end of eight days the corresponding figures were .303 and .310.

The result indicates that the primary factors controlling rate of regeneration are not those inherent in the condition of the cells which proliferate to form the regenerated tail. They are rather to be sought in the influence exerted by other parts of the organism.

The Function of the Efferent Fibers in the Optic Nerve of Fishes: Leslie B. Arey, Northwestern University Medical School. (Introduced by G. H. Parker.)

When the optic nerve only of *Ameiurus* is severed, the rods, cones and retinal pigment fail to execute their characteristic photomechanical responses. After hemisection of the nerve, movements of the elements occur only in that region of the retina adjacent to its intact side. It can not only be shown (since essentially normal responses occur in excised eyes and in eyes attached to the body by the optic nerve only) that a second mechanism exists in association with the muscles innervated by the oculomotor nerve, which inhibits these movements when the optic nerve is cut, but also that electrical stimulation of the peripheral stump of the optic nerve can overcome this inhibition.

Hence demonstrably functional efferent fibers exist in the optic nerve. Only by the balanced action of these components with a second extrinsic set of fibers (ciliary nerves?), which independently exert an inhibitory influence upon the movements of the retinal elements, are normal photomechanical responses accomplished. It is probable that efferent impulses in the optic nerve do not directly stimulate the retinal elements to motion, but rather act indirectly by blocking the tonic inhibition exerted by the second system. These efferent optic nerve fibers may be designated as visceral efferent nerve components.

Severance of the optic nerve of *Abramis* or *Fundulus* does not prohibit movements of the retinal elements, hence it is impossible to state whether the mechanism discovered in *Ameiurus* is or is not peculiar to that species alone.

The Relation of the Body Temperature of Certain Cold-blooded Animals to That of Their Environment: Charles G. Rogers and Elsie M. Lewis, Oberlin College.

A review of the literature upon the subject of the body temperatures of the so-called cold-blooded animals reveals a lack of uniformity of observations in part, at least, due to faulty methods of determination.

A knowledge of the temperature relations existing between cold-blooded animals and their environments is of importance in all experiments having to do with the determination of temperature coefficients of the rates of reaction of physiological processes. If the relation can be shown to be a constant one it is necessary only to control carefully the temperature of the environment in order to have knowledge of the actual temperature of the animal or tissue under observation.

Tests made upon earthworms, clams, two genera of salamanders and upon the gold fish by means of carefully guarded thermoelectric measurements indicate that in general these animals adjust themselves to the temperature of their environment with remarkable exactitude, within a very short time, the difference being usually measurable only in thousandths or hundredths of a degree Celsius.

Observations on Regeneration and Division in Ciliates: GARY N. CALKINS, Columbia University.

A definite division zone, not affected by loss of parts through cutting, has been demonstrated in *Paramecium* and *Uronychia*. In *Paramecium* regeneration of enucleated fragments never occurs, while regeneration of nucleated fragments varies with the race used. In *Uronychia* regeneration of nucleated fragments always occurs, and regeneration of enucleated fragments varies with age of the cell when cut. If cut within eight hours after division the latter never regenerates; if cut within two hours prior to division it invariably regenerates into a perfect, but enucleate, cell.

Precocious formation of powerful cirri, before division, is characteristic of *Uronychia*. This, and regeneration, are phenomena of the same type, both functions of the fully differentiated protoplasm. The experiments indicate differences in protoplasmic make-up in young and old cells; and the increasing power of regeneration with age in enucleated fragments indicates an increasing differentiation. When fully differentiated, enzymes are formed leading to precocious organ formation.

Cell division occurs when differentiation has gone a step beyond that necessary for regeneration. Enzymes are then produced which bring about cytolysis of the specialized protoplasm in the division zone. Through tension of the cell the membrane turns in and the cell divides by constriction.

With chemical activities at division the protoplasm is restored to the labile undifferentiated condition of young cells. If this restoration is incomplete a progressive differentiation of the racial protoplasm occurs, leading to depression and death, which are prevented by drastic reorganization phenomena of asexual, and sexual, endomixis.

The Distribution of Water in the Embryonic Nervous System: O. C. GLASER, University of Michigan.

Embryonic nervous systems of *Rana pipiens* contain more water anteriorly than posteriorly. Donaldson has found in the adult a difference in the same sense. The determinations in the embryonic material were necessarily made with systems incompletely isolated from other tissues.

An indirect method, free from this objection, gives the same result. Nuclear volume varies with the water content of the cell. In the nervous system only relative nuclear volumes can be dealt with, but the evidence from thousands of nuclei shows that the anterior ones are larger than the posterior, not only during folding, but also in the flat neural plate.

In the theory of autonomous folding which I have tried to develop, absorption of water is a symptom of surface changes in the neural cells, and these changes are held responsible for the folding. If correct, and if nuclear size is an index of water content, then nuclei in the curling edges of the neural plate should be larger than those in the flat portions of the plate at the same level. This, as the detailed evidence to be presented shows, is true.

From the beginning, then, the anterior end of the vertebrate nervous system has a higher water content than the posterior, and the absorption of water accompanies folding.

The Comparative Resistance of Marine Animals from Different Depths to Adverse Conditions: V. E. SHELFORD, University of Illinois.

Benthic animals from different depths differ strikingly in their resistance to adverse conditions. Individuals of the same species taken from different depths show the same relations as do species living at the same or correspondingly different depths. In general animals from two fathoms are two to three times as resistant to fresh water and high temperature as animals from seventy-five fathoms. Animals from deeper water are usually more resistant to excesses of acid and alkali than those from shallower. The differences in physiological character within single species show the unreliability of conclusions regarding distribution based on the assumption that physiological characters are uniform for entire populations.

The Change of the Blowfly Larva's Photosensitivity with Age (illustrated with charts): BRADLEY M. PATTEN, Western Reserve Medical School.

Larvæ of the blowfly were tested each day from hatching until pupation to determine what, if any, changes take place in the degree of their photosensitivity. The test employed consisted in subjecting maggots crawling under the influence of a horizontal beam of light to an instantaneous change of 90° in the direction of beam. The resulting change in the direction of the animal's

locomotion was measured in degrees by means of a protractor. The more sensitive the individual was, the more closely did its deflection approach 90°. Using the same larvæ throughout the experiments, one hundred trails were run each day. The *average deflection* of each of these sets of 100 trails was used to locate a point on an "age-sensitiveness" curve.

The curve of photosensitivity thus obtained shows a rapid rise during the first days of larval life, reaching a maximum on the fourth day with a deflection of 81°, and gradually dropping off till the time of pupation, when the average deflection was 58°.

The Physiology of Chemoreceptors: W. J. Crozier, Bermuda Biological Station.

A comparison of quantitative measurements of cell penetrability for acids with the relative stimulating powers of these acids and with the limiting dilutions beyond which they are ineffective in stimulating earthworms and four species of marine animals indicates: (1) that an acid stimulates by union with a constituent of the ceptor surface, and (2) that this surface is not simple but complex and contains probably proteins and fatty substances.

Encystment of Didinium nasutum: Gary N. Calkins, Columbia University.

Encystment of *Didinium* under culture, with adequate food and normal conditions, is preceded by a declining division rate in the race as a whole. Encystment lasts for about six days, when the organisms emerge with renewed vitality, as shown by an average division rate from five to ten times greater than that prior to encystment.

During encystment the cell undergoes complete reorganization. The macronucleus degenerates into fragments which are ultimately absorbed in the protoplasm. The micronuclei swell and divide by mitosis, the products giving rise to new macro- and micro-nuclei.

This reorganization occurred twice during the history of my *Didinium* culture with an interval of six weeks. After the second period the race did not encyst again, but continued to live with a slowly decreasing division rate for about six months, when the last individuals died with characteristic symptoms of depression.

The individual *Didinium* isolated was evidently well advanced in its racial cycle. This is indicated not only by loss of powers of encystment and reorganization, but also by the fact that *after* the two periods of encystment, and for ten days only in each case, epidemics of conjugation occurred in the stock material derived from organisms which had recently encysted. Asexual reorganization, apparently, merely restored the protoplasm to a condition in which conjugation was possible; a condition which is, in itself, evidence of advanced differentiation, and a condition from which the protoplasm is restored through conjugation.

On Cell Penetration by Acids: The Effects of Anesthetics and of Stimulation by Induction Shocks: W. J. Crozier, Bermuda Biological Station.

1. Anesthetics produce a reversible decrease in the permeability of *Chromodoris* tissues toward a range of dilutions of strong acids. The magnitude of the effect depends upon the concentration of the individual anesthetic and the time of its action, and may prolong penetration time by 100–200 per cent. Following the decreased permeability there ensues an increased permeability, irreversible in its later stages, which can be antagonized (delayed) by balanced salt solutions. Cytolytic agents increase permeability toward acids.

2. Stimulation by induction shocks decreases the penetration time of acids. The decrease in permeability toward acids produced by anesthetics may be inhibited by simultaneous strong stimulation.

Behavior of Holothuria captiva Toward Balanced Illumination: W. J. Crozier, Bermuda Biological Station.

The whole surface of *Holothuria* is reactive to light. These animals are negatively phototropic. In *H. captiva* the two sides of the animal are sensibly parallel, and when subjected to bilateral illumination there is accordingly no possibility of equalizing the amount of light on the two sides by assuming a position perpendicular to the axis of the opposed beams, or, in case these beams are of unequal strength, by pursuing a path at some definite angle with this perpendicular. This is in accord with the behavior of *Holothuria* and proves that photic stimulation in this animal depends upon the amount of light falling upon the sensitive surface, and is independent of the *angle* of incidence. The fact that isolated portions of the skin react to continuous light is further and conclusive evidence that the direct action of light, not change of intensity, furnishes the stimulating agency.

Caswell Grave,
Secretary-Treasurer

(*To be continued*)